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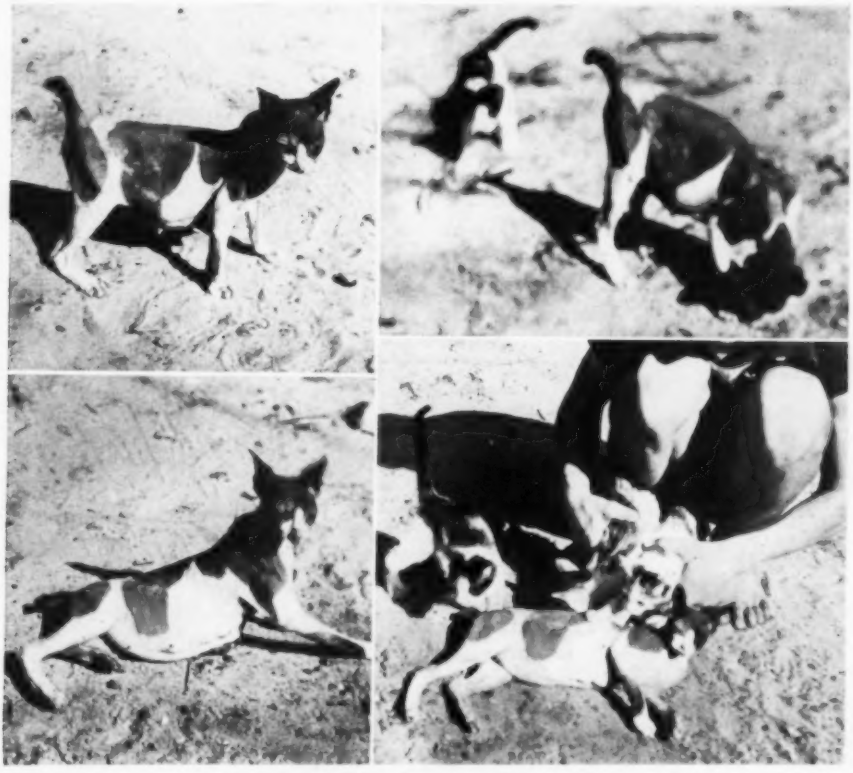
The Journal of HEREDITY



"NONESUCH" HAS KITTENS

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A New Approach to Eugenics

Race Differences in Taste Acuity

Lethal Characters in Animals and Man

An Early Horse Skeleton

What Is a Hybrid?

VOLUME 28 SEPTEMBER, 1937 NUMBER 9

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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The

Journal of Heredity

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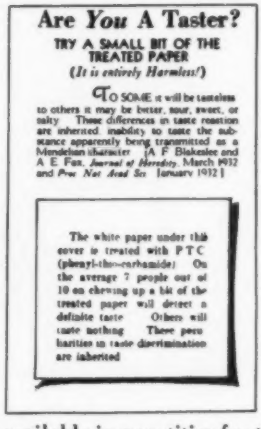
Are You A Taster?
TRY A SMALL BIT OF THE TREATED PAPER
(It is entirely Harmless!)
TO SOME it will be tasteless to others it may be bitter, sour, sweet, or salty. These differences in taste reaction are inherited inability to taste the substance apparently being transmitted as a Mendelian character (A. F. Blakeslee and A. E. Fox, Journal of Heredity, March 1932 and Proc. Nat. Acad. Sci. January 1932)
The white paper under this cover is treated with PTC (phenyl-thio-carbamide). On the average 7 people out of 10 on chewing up a bit of the treated paper will detect a definite taste. Others will taste nothing. These peculiarities in taste discrimination are inherited

LEAFLETS TO DEMONSTRATE HEREDITY

Last year the "Taster test" served as an introduction to human genetic differences in many classrooms. The test is so easily made with the treated paper, and arouses such great interest that it appears to have a definite place in group demonstrations of such differences. These leaflets, size 3⅜" by 5½", are available in quantities for those who wish to use them for classroom or lecture purposes. On the back is printed an outline 4-generation pedigree chart. Sample on request. Prices: 10 for 25c; 50 for $1.00.

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THE OAT FLOWER

Frontispiece

So small and delicate is the oat flower that it offers special problems to the breeder. To emasculate it without unnecessary injury and rapidly enough to avoid fatal drying, requires both skill and luck. On the left is an oat floret with the glumes drawn aside to show the flower parts exposed,—magnified about nine times. The three anthers and the feathery stigma stand forth clearly at the base of the floret. At the right are shown the reproductive parts enlarged about twelve times. Successful hybridization hinges on the removal of the tiny anthers before they shed their pollen, without injuring the stigma or ovary.

FACTORS INFLUENCING SEED SET IN OAT CROSSING

F. A. COFFMAN*

OATS long have been recognized as especially difficult to cross. The operation of crossing is tedious and exacting and requires skill and patience. Proficiency may increase with practice, but with present technique an average of probably not more than 25 flowers can be emasculated and carefully pollinated in an hour. Few data are available on factors influencing seed set in oat crossing. Consequently, any information that may facilitate successful hybridization should be helpful. This paper describes the writer's method for crossing oats and presents data on the effect of temperature, time of day, and other factors upon the seed set after artificial pollination of oat flowers.

Technique of Oat Crossing

The technique of oat crossing differs with each plant breeder. No method is perfect and few breeders obtain even a reasonably satisfactory seed set as compared with the crossing of wheat or barley.

The technique here described has resulted in more than average success. It has been developed over a period of years through experience and the incorporation of the ideas and methods of various cereal breeders.

The only instrument used by the writer is a pair of slender dissecting forceps having curved prongs that contact exactly at the tips. The curved prongs are believed to be preferable, especially for lifting out the anthers, although forceps with straight prongs are used successfully by others. Additional instruments seem unnecessary and they merely make the operation more complicated.

Emasculation is easiest when the outer glumes of the spikelet, having attained full length, start to separate at their tips (Figure 2*A*). This normally occurs shortly before anthesis. The size and toughness of the glumes varies in different oat varieties. The glumes of *Avena byzantina* varieties usually are thicker than those of some varieties of *A. sativa* and are not so subject to mutilation in the operations involved in crossing.

The tip of the outer glume adjacent to the secondary floret of the oat spikelet extends slightly beyond that of the other empty glume (Figure 2*B*). In emasculation the base of the spikelet is held between the thumb and forefinger with the secondary floret nearer the operator. The longer glume is then grasped with the forceps, bent downward, and held with the thumb. The secondary floret is pinched off and discarded, which leaves the primary palea facing the operator. The forceps are then inserted between the lemma and palea margins and the palea is grasped and drawn down until it can be caught and held with the thumb (Figure 1). This exposes the floral organs (Frontispiece) and permits the anthers to be removed readily with the forceps.

The writer limits crossing operations to the uppermost five spikelets on a panicle because frequently no more than five are in condition to be pollinated at the same time. Unaltered spikelets are removed only when they interfere with tying the protective bag over the emasculated florets.

Secondary florets are removed and not pollinated because (1) they usually develop more slowly and reach anthesis later than primary florets; (2) their smaller size increases the difficulty of emasculation and pollination; (3) they more frequently are sterile; and (4) their smaller size may make the production of strong plants less certain.

The floret is ready for pollination im-

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MANIPULATING THE OAT FLOWER

Figure 1

Detailed view (enlarged about twice) of the method of holding an oat spikelet while the flowers are being emasculated or pollinated. The glumes are held down by the thumb while with the other hand the anthers are removed or the pollen applied. The stem of the plant must not be broken in the process, nor the delicate parts of the flower injured. The work of pollination is exacting and tedious, but society reaps much benefit in improved varieties of grain. About 25 florets an hour can be pollinated, and from a fifth to a third of the pollinated flowers will set seed if the breeder is fortunate.

mediately following emasculation when emasculation is done just prior to natural anthesis. Otherwise the florets may become receptive a few hours to a few days after emasculation.

Oat varieties differ widely in size of anthers and in the quantity of pollen they contain. In pollination the practice has consisted of gathering a few well-developed spikelets or an entire panicle from the male parent and removing the anthers just before applying the pollen. After removing a few anthers they are held in the back of the crotch between the thumb and index finger. An anther is inserted in the floret with the forceps, bruised against the lemma, and, if it bursts abruptly, throwing a noticeable shower of pollen over the feathery stigma, fertilization may reasonably be expected. Without this, results are not promising. After pollination, it is extremely important to replace the lemma immediately to prevent the floret from drying out and then to draw the outer glume back to its normal position.

Obtaining anthers in suitable condition is a problem, especially when the crossing is done in the greenhouse. The stage of development of pollen is indi-

OATS IN BLOOM

Figure 2

Photographs of separate florets (enlarged about twice) and of the tip of a panicle showing three stages of blooming. *A*—Before anthesis,—that is, before the pollen is shed. *B*—During anthesis,—at which time the pollen is shed and fertilization normally occurs. *C*—After anthesis, when the flower has been fertilized and growth of the seed has begun. The awn has begun to project from the developing seed in the floret at the end of the panicle at the right.

cated by the extent to which the outer glumes have parted. Spikelets in the best condition to furnish pollen are a trifle more advanced than are those previously described as being in the stage most favorable for emasculation. Anthers in prime condition swell perceptibly and start splitting longitudinally within two minutes or less when laid on the hand.

A thin but tough pliable glassine bag just large enough to cover the emasculated spikelets has proved most satisfactory for protection. The rachis and peduncle are less likely to be broken by wind when small bags are used. The open end of the bag may be placed in the mouth and inflated, which, at the same time, will moisten and soften the edges, after which it can be slipped over the pollinated florets easily and tied securely. Moistening the edges facilitates tying the bag tightly about the rachis, thus practically insuring the exclusion of insects and foreign pollen.

Wool yarn, previously used by Dr. Harry V. Harlan, of the Division of Cereal Crops and Diseases, in the hybridization of barley, has proved most satisfactory as a tie. It is strong, light, and elastic. The crossed panicles can be located most readily when red or black yarn is used. Any small, light weatherproof string tag will serve as a label;

POLLINATION COMPLETED

Figure 3

An oat panicle with glassine bag tied in place with colored woolen yarn and labeled with date and parents of cross. If no catastrophe of wind or rain breaks the stalk of the plant, the breeder may have a few hybrid seed to put into the ground the following spring.

red or white tags are easiest to see.

A bag and label on an emasculated panicle are shown in Figure 3.

Data Obtained

The crossing technique described has been followed in general for more than 12 years. During that time more than 1,000 oat panicles have been pollinated with varying degrees of success. Available records show that only 281 of 980 panicles, or 28.7 per cent, produced seed. Each hour spent in crossing produced less than two crossed seeds. The oats used as parents in making these crosses belonged to the species *Avena sativa* and *A. byzantina*. All leading agricultural varieties of the United States have been used as parents. No indications of incompatability were observed in these crosses. The degree of success in crossing varied widely, evidently being influenced by conditions under which crossing was attempted. Success varied from year to year in both field and greenhouse. The greatest single problem in crossing oats was in finding sufficient pollen in prime condition. This was especially true in the greenhouse, if the temperature had been cool or was cool when crossing was attempted.

Greenhouse and Field Pollinations

Records are available of crosses attempted in the greenhouse at the Arlington Experiment Farm, Arlington, Va., and in the field at the Aberdeen Substation, Aberdeen, Idaho, where oats are grown under irrigation. Data presented in Table I show that in 588 attempts to cross oat panicles in the field 23.98 per cent set seed. In the greenhouse 35.71 per cent of 392 panicles artificially pollinated set seed. The difference in percentages shows that almost 50 per cent more panicles set seed in the greenhouse than in the field. The greenhouse is preferred to the field for oat crossing because of this higher average seed set, probably a result of the greater humidity in the greenhouse.

The most successful day's crossing in the field at Aberdeen took place on August 5, 1935. Seeds were obtained in 7 of the 9 panicles pollinated that day and 32.6 per cent of all flowers pollinated set seed. The temperatures on that date were: Maximum 93°, minimum 42°, and mean 67.5° F. Evaporation from a free water surface was 0.286 inch. The evaporation was next to the lowest recorded for the period during which crosses were being made and followed a day when the evaporation was 0.487 inch, the highest recorded. The sky was clear and the wind velocity averaged only 2.5 miles per hour for the 24 hour period. Almost equally successful results have been obtained once or twice in the greenhouse at the Arlington Experiment Farm. On March 13, 1931, 7 out of 10 panicles and 46.0 per cent of the flowers pollinated produced seed.

Influence of Time of Day on Seed Set

Those familiar with the oat plant are aware that flowering usually occurs in the afternoon. Data and observations published by Fruwirth[3], Rimpau[6], Kőrnicke and Werner[4], Zade[7], Denaiffe and Sirodot[2] and Callaghan[1] indicate that in Germany, France, and England pollination in oats usually reaches its maximum between 3 p. m. and 4 p. m. According to Callaghan, however, oats pollinate most freely in Australia between 4 p. m. and 5 p. m. Misonoo[5], who published detailed data on the blooming of the oat flower in Japan, found that flowering occurred from 12:45 p. m. to 5:45 p. m. It ordinarily lasted for about one hour and occurred most intensively between 2 p. m. and 3 p. m. Misonoo observed that blooming occurs while the day temperature is falling from its high point. Observations made in the course of these studies indicate that oat pollination normally reaches its maximum between 3 p. m. and 4 p. m. in the field at Arlington, Va., Aberdeen, Idaho, and Ames, Ia. In the greenhouse at Arlington, Va., oats frequently pollinate freely before 3 p. m. and pollination may diminish sharply before 4 p. m. It has been rather difficult to obtain prime pollen for crossing at other times of the day, although many attempts have been made to make crosses at other than the optimum period for natural anthesis.

A comparison was made of the data

obtained at Aberdeen, Idaho, in 1934 on oat florets pollinated artificially in the morning and of those pollinated in the afternoon of the same days. The data are presented in Table II. A total of 708 florets on 152 panicles was pollinated. Only 15.15 per cent of the panicles and 4.28 per cent of the florets pollinated in the morning set seed, as compared with 22.69 per cent of the panicles and 9.76 per cent of the florets pollinated in the afternoon of the same days. These data indicate clearly the superiority of the afternoon, or the normal flowering time of the oat, for pollination, as the seed set was more than doubled. Oats can be crossed most readily between 2 p. m. and 5 p. m. and pollination at other hours of the day might ordinarily be suspended. Satisfactory results have been obtained when the florets were emasculated in the morning and pollinated in the afternoon.

Influence of Temperature on Seed Set

Numerous crosses were made at Aberdeen, Idaho, in 1925, 1934, and 1935. Data were recorded for pollinations made on about 2,800 florets on 588 panicles.

In Table III are presented data on the relation of maximum daily temperature to percentage of seed set in artificially pollinated oat florets. The relation of maximum temperature to percentage of seed set is very striking. The highest percentages were obtained on rather cool days. Little success resulted from pollinations made on days on which the maximum temperature exceeded 95° F. Success is so uncertain on very hot days that pollinations might well be suspended. The oat pollen and floral parts are believed to dry out so quickly when exposed to high temperature that the pollen tube never reaches the ovary.

Influence of Evaporation on Seed Set

There are no available records on the relative humidity at Aberdeen, Idaho. Records are available, however, on the daily evaporation from a free water surface during the period crosses were made in 1935. Data on the relation between evaporation and seed set in artificially pollinated oats are presented in Table IV. Daily evaporation apparently is definitely related to seed set. On days that evaporation was greatest, the seed set was lowest, and on days of least evaporation the seed set was highest. The organs of the oat floret apparently are extremely sensitive to drying. Observation has indicated that this is one of the most common reasons for failure in oat crossing. The more promptly and completely the palea and outer glumes can be returned to their original positions after the crossing manipulations, the better are the chances of success. Also, mutilating the glumes or the ovary appendages when emasculating and pollinating the oat floret greatly reduces the chances of success. Florets mutilated to any extent usually dry very quickly and badly mutilated ones rarely set seed.

Influence of Wind Velocity on Seed Set

Frequently, though not necessarily, a close correlation exists between wind velocity and evaporation. Data obtained in 1935 did not indicate that success in crossing is related to wind velocities

TABLE I. Results of oat crossing in the field at Aberdeen, Idaho, and in the greenhouse at the Arlington Experiment Farm, Arlington, Va.

Year	Number of Panicles Pollinated	Setting Seed	Percentage Setting Seed
	Field		
1925	256	31	12.78
1934	175	50	28.90
1935	190	60	31.58
Total or Average %	621	141	22.98
	Greenhouse		
1925	58	11	18.97
1927	60	39	48.75
1928	81	28	28.40
1929	4	2	50.00
1930	42	9	21.43
1931	41	23	56.10
1932	13	8	61.54
1933	32	9	28.13
1934	41	16	39.00
Total or Average %	392	140	35.71

TABLE II. Seed produced by emasculated oat florets artificially pollinated in the morning or in the afternoon of the same days at Aberdeen, Idaho, in 1934.

Time pollinations were made	Panicles Pollinated	Panicles Producing Seed		Florets Pollinated	Florets Producing Seed	
	Number	Number	Per cent	Number	Number	Per cent
A. M.	33	5	15.15	165	7	4.28
P. M.	119	27	22.69	543	53	9.76

TABLE III. Relation of temperature on date of pollination to seed set in oat florets previously emasculated.

Temperature Ranges by Maximum	Panicles Pollinated	Panicles Setting seed		Florets Pollinated	Florets Setting seed	
	Number	Number	Per cent	Number	Number	Per cent
81-85	27	16	59.26	135	23	17.04
86-90	113	87	80.32	564	73	12.94
91-95	277	98	30.69	1304	148	11.35
96-100	154	6	3.90	779	9	1.24
101	17	2	11.77	85	2	2.35

TABLE IV. Relation of evaporation from a free water surface on date of pollination to seed set in oat florets previously emasculated.

Daily evaporation	Panicles Pollinated	Panicles Setting seed		Florets Pollinated	Florets Setting seed	
Inches	Number	Number	Per cent	Number	Number	Per cent
0.201-0.300	49	21	42.86	202	32	15.84
0.301-0.400	151	57	38.74	387	57	9.71
0.401-0.500	10	2	20.00	38	2	5.26

ranging from 2 to 5 miles per hour for 24 hours, although very high velocities may cause excessive whipping about and drying of the flowers.

Summary and Conclusions

The technique developed in the course of 12 years of crossing oats is described. During this period more than 5,000 florets on more than 1,000 oat panicles have been emasculated and pollinated. Slightly less than one-tenth of these florets and slightly more than one-fourth of the panicles set seed. Approximately one hour's work is required to obtain a cross, but the effort seems amply justified in view of the numerous valuable disease-resistant oat selections that have resulted. It has been found that the greenhouse is more favorable than the field for crossing oats, although in the greenhouse excessively low temperatures result in spongy anthers and a paucity of pollen.

The most favorable time of day for crossing oats is between 2 and 5 o'clock in the afternoon, at which time blooming is at the maximum. Other times of the day are less favorable and should be avoided, if possible.

In the field, a low seed set usually is obtained from pollinations made on days when the maximum temperature exceeds 95° F. On very hot days the flowers dry so quickly that crossing operations may well be suspended.

Low evaporation is favorable for oat crossing in the field. High evaporation usually accompanies low humidity and both of these factors are partly a result of high temperatures. Consequently, the low seed set obtained at high temperatures may be due in part to rapid drying, rather than to lethal temperatures.

Wind is not an important factor in oat crossing, unless the velocity is high enough to damage the panicles by whipping or interferes with pollination by blowing the pollen.

Observations have indicated that lack of experience in crossing frequently results in the mutilation of oat florets and a low seed set.

The percentage of seed set in 1934 was more than double that obtained in 1925, probably largely as a result of improved technique.

A study of temperature, humidity, and light relationships, followed by their control in the greenhouse, should reduce failures to a minimum and permit crossing between certain oat species now considered almost impossible.

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Population Index

THE first number of *Population Index*, a guide to current demographic materials for students, research workers and teachers, appeared in January. The *Index* is published quarterly by the School of Public Affairs, Princeton University, and the Population Association of America. It continues the Association's bibliography, *Population Literature*. The current number contains two entirely new sections, Current Items and Statistics, in addition to a bibliography covering more than 400 recent books and articles. Current Items is devoted to notes on matters of special interest to students of population, such as announcements or reports of meetings and comments on new developments. The Statistics section presents population and vital statistics for a large number of countries as well as special data for the United States. The *Index* goes to all members of the Population Association. Others wishing to receive it may write to the Office of Population Research, 20 Nassau Street, Princeton, New Jersey.

A NEW APPROACH TO EUGENICS

Leaders in Recreation, Nursing, Education, Medicine, Stress Need for Eugenic Outlook

RECENT studies by psychologists have thrown new light on the distribution of intelligence among our people. If we assume that other socially valuable qualities are distributed in about the same way as intelligence, the findings of psychologists might be summarized as follows: to whatever extent the larger socio-economic groups may differ in the average biological capacity of their members, such differences are known to be relatively small compared to the differences which exist among different individuals within the same groups. Individuals with superior capacities are widely scattered throughout the population.

Under these conditions, the major problem of eugenics is to give superior families in every social class and occupation, a greater desire to reproduce their kind, and a better opportunity to do so. Perhaps it will not be possible to pick out the superior families until more equal opportunities are offered to all our people. Eugenics recognizes more than ever before that certain basic conditions of society must be established before eugenics can be widely effective in bringing about a better distribution of births. First, economic relationships must be so modified that if people want large families, they can have them without suffering undue handicaps. On the other hand, effective means of family limitation must be universally and cheaply available to married people for the purpose of enabling them to limit the size of their families if they desire to have few children.

These changes are necessary in order to establish that relative freedom of parenthood which appears essential to the application of eugenics on a large scale in a free country. The economic changes will not be easy to bring about, though we may say in passing that the interesting population experiments now going on in Europe give us better grounds than we have had before for feeling that such changes are possible and not Utopian.

Thus, we may well be working towards a society which does not impose parenthood on some by denying them contraceptives, nor attach over-heavy financial penalties to parenthood on the part of others. But such a society would not necessarily be eugenic because of these conditions. Whether or not it be a eugenic society would depend on the attitudes, the sense of values, the interests, even the physique, of its citizens, and the general conditions under which they live.

We may assume that the superior families include those which are most susceptible to the influence of education, better forms of recreation, better housing, and other attempts to improve society. It is therefore important that our education should not be of a kind to diminish the desire to have children, nor our improved housing to be of a kind which would tend to prevent the fulfillment of that desire. The eugenic implications of education, recreation, housing, medicine, and all other efforts to improve human conditions, become very significant when viewed in this way.

The directors of the American Eugenics Society have felt that to bring about a process of individual selection, eugenics must work through existing social agencies. To test the possibilities of this new approach, a series of Conferences was held in the early part of 1937, with leaders in Recreation, Nursing, Education, and Medicine. Many new aspects of eugenics developed during these discussions, some of which are described in the pages which follow.—Foreword to report of "Conferences on the Relations of Eugenics in the Fields of Recreation, Nursing, Education and Medicine," American Eugenics Society, May 14, 1937.

The following are excerpts from the 38-page report:

Recreation and Eugenics

We reviewed the major values in organized recreation that have importance for eugenics. Among them were: (a) the development of courage, physcial strength, nervous strength, early experience in community life and adjustments, experience in leadership, experience in self-control, good health habits, physical efficiency and recreational skills; (b) emotional guidance for children as a stabilizing factor in later life; (c) self-management by children of their own lives as preparation for critical periods of maturity in which marriage and parenthood are most important.

* * *

There were also detected some omissions and some imperfect attacks on recreational needs.

(a) For example, it was brought out that while most rural districts have recreational activities, well organized for children up to fifteen and again for older people after marriage, there is a notable gap in activities for the ages 15 to 25, *which is just the age when decisions as to migration from country to city are likely to be made.* This lack together with economic and other forces may have strongly influenced the flow of young people from rural areas to the city, with a consequent lowering of the birth rate of the migrants.

(b) Recreation leaders have done a little to encourage family recreation directly, but it is not very much compared with their other efforts, it was stated. If one considers the whole sweep of governmental and semi-public recreation service, from neighborhood houses to the National Park Service, the picture is more favorable than that suggested in our discussions. The campers at the public sites of New York State in the Adirondacks and elsewhere are overwhelmingly family groups, and it is the family that goes picnicking and hiking in the reservations of the Essex and Union County park systems of New Jersey and elsewhere in outlying parks. Outdoor family recreation is steadily increasing. Nevertheless, the unobtrusive encouragement of indoor and outdoor family recreation may fairly be said to have only begun.

(c) Recreation leaders are now awakening to the importance of co-recreation for young men and young women of sixteen to say twenty-five. Sixteen to twenty has been called the "dating" age, and twenty to thirty the "mating" age. This age group has relatively been neglected as far as the promotion of common recreational activities is concerned. Yet shared experience in the chores, play activities and discussions which are part of camping, hiking, planning socal events and other recreations is sound preparation for successful marriage.

* * *

If we do all these things—and a few other very important things which recreation leaders know should be done—shall we have large families among the groups most fitted to have them? We have no proof that all that has been done so far has worked in that direction. As to past and future relationships of this sort, we shall require the help of research workers and statisticians. In any case, we can hope through these measures to enjoy more and better recreation, which in itself would be a substantial gain to community life in the United States.—Weaver W. Pangburn, *Nat. Recreational Assoc.*

Nursing and Eugenics

From her experience in homes, the public health nurse sees the place for a positive eugenics program which will look to the following:

1. A carefully planned effort to implant in the minds of the able, healthy young Americans —through churches, magazines, newspapers, radio, etc.—that children, several in each family, are highly desirable. It seems imperative that high schools and colleges be prepared to incorporate into their plan of education, effective preparation for homemaking and parenthood.
2. Improved housing, so that home-making may be possible.
3. If needed, economic aid to the able young people who should have children, in the form of marriage loans, maternity benefits, etc.
4. Safeguarding of home and income through some type of provision for periods of sickness and unemployment.
5. The promotion of pre-marriage consultation service, with complete health examinations of man and woman.
6. Marriage consultation, combined with maternity service of acceptable quality and at such cost as the self-respecting family can afford.
7. Undergraduate and graduate courses, including scientific eugenic facts with their sociological and health implications for all those who work in the field of family health service. Perhaps the eugenics experts might study the courses available and suggest more practical and effective content and method.
8. Education and legislation which will permit and require sterilization of those who can not produce desirable offspring.—Alta E. Dynes, *Assoc. for Improving the Condition of the Poor, New York City.*

Education and Eugenics

Apparently there is now a real movement for courses of this sort [a new course of lectures at Vassar on "marriage and the family," which had immediately attracted over 500 students] at men's colleges as well as at women's. The eugenic implications of these courses have been indirect and far more effective than if the students were told it was their duty to have more children. The importance of this finding as to the value of the indirect method cannot be over-emphasized. Eugenic approach must be made through the environment of the student, economic, cultural, its aspiration for so-

cial justice, and the proper atmosphere in all the social sciences. In other words, eugenic propaganda will go furher if it is treated as incidental to all other social advance.

The natural disposition of young women is conservative. The post-war reaction is over, the time is ripe for the eugenic group to give the educator a eugenic philosophy which can without obtruding itself permeate all aspects of education.—Dr. Henry N. MacCracken, *President of Vassar College.*

It is worth noting that today we must specifically and deliberately ask about the relation of formal education to eugenics and the aims and purposes of the modern eugenics movement in this country. When we pause to reflect on the situation it is, indeed, curious that we should raise that question, because it is difficult to see how any educational program can or should be unrelated to the betterment of the conditions, the attitudes and the practices that govern the bearing and rearing of children. It happens, however, that our formal education derives in large part from traditions and sources that either neglected or scorned such mundane things as the family, marriage, and child bearing and rearing. Academic education has been preoccupied with mental discipline, with science and scholarship, the training of the mind, and, more recently, with preparation for vocations. It could, with fair justification, neglect the other aspects of life because both the home and the church were ready, willing and able to provide the kind of education for young people for marriage and family life and child rearing. It is generally agreed, however, that present day conditions of living have changed so markedly and the advances of knowledge have been so great, that the traditional education of the family is no longer adequate. Moreover, it is clear that the cultural traditions that had been transmitted by the home and the church are no longer integrated and strongly sanctioned as earlier, nor are they appropriate to present day living.

* * *

We may look forward, then, to a growing recognition in organized education of a legitimate need for nursery schools that will provide really competent supervision, mental, physical, nutritional, social, of the young child's development; parent education and child study meetings to keep the parents informed of the newer developments in child rearing, and to communicate the newer insights and understandings about wholesome personality development and the protection of the child's mental health; school medical services, physical education and hygiene, psychiatric services and the wide variety of instruction and wise supervision of activities, athletic, artistic, recreational, etc., so necessary to rounded, wholesome development and social adjustment of children; and, more generally, the adoption of the conception of the school as essentially *the* child welfare agency of society. Only too often does the school appear to be dominated by the feeling so well expressed many years ago by Agnes DeLima in the title of her book, "Our Enemy the Child."

Children need an immense amount of affectionate understanding, toleration and intimacy if they are to grow up to be mature, non-conflicted, and well adjusted adults, both capable and ready to accept the responsibilities of marriage and parenthood. With families today suffering so much from marital conflicts, emotional disturbances and broken homes, there is a special need on the part of the schools to provide an atmosphere markedly reinforced by genuine affection and tenderness to enable children to bear the emotional disturbances from which so many of them now suffer. The accumulating clinical evidence shows increasingly clearly that the all too frequent emotional maladjustments of adult life, that prevent men and women from marrying and having children, arise from their unhappy childhood, when they have been deprived of much needed love and affection and of the opportunity to give affection. These personality difficulties are peculiarly frequent in the very superior men and women who have the most to contribute physically and mentally to the next generation. In the larger perspective of social development, we can well afford to sacrifice some of the much prized academic competence and skills for the sake of better integrated, more wholesome minded boys and girls, who can go forward to maturity with less fears, less anxieties, less neurotic conflicts and disabling maladjustments, all of which we must recognize have a profound influence upon their attitude toward marriage and child bearing. From various experimental schools it is already being shown that their formal education is more effective when given in a setting of warm concern for the child.

* * *

Thus the task of mental hygiene, in its larger proportions, is similar to the program of eugenics, as it is now stated, since it is clear that any effective program of education for eugenics must be predicated upon this same concept of mental hygiene. We cannot, merely by teaching biology and the mechanisms of heredity, or by pointing with alarm to the falling birthrate, expect to exercise any significant influence upon the conduct of men and women with respect to marriage and child bearing. Learning is governed largely by the selective awareness of individuals who receive knowledge and experience in terms of their curiosities, their perplexities, their anxieties and their aspirations, not merely their intellect. In these important areas of life activity, behavior is governed essentially by the emotional attitudes men and women show toward life, by the values they have learned to cherish, and by the personal, emotional freedom that enables them to go forward to adult life with hopefulness and with confidence that through marriage,

through sex fulfillment, and through the bearing and rearing of children, they can and will find their richest and most significant fruition.

* * *

We must recognize that the general acceptance and practice of the control of conception today is rapidly bringing a religious crisis; for the first time men and women are confronted with the necessity of deliberately affirming or denying life. Heretofore, child bearing has been largely involuntary and unplanned and this helplessness has been met with resignation and the religious injunction to accept these involuntary responsibilities; but today, with conception becoming more and more a question of voluntary and affirmative action, it is clear that men and women need a religion that will give a new faith and courage and will bring conviction about life that will emotionally justify procreation. To what extent and in what fashion organized education can meet the need for such an affirmative philosophy of life is, indeed, a searching question. Perhaps we can say that to the extent organized education will genuinely strive to foster saner and more wholesome personalities, not individuals who are fighting a lifelong battle of rebellion against their parents, not individuals who are neurotically afraid of responsibility or sex functioning; but individuals who are able and willing to find their fulfillment in merging themselves into the ongoing stream of life,—then organized education will have made its contribution to the goal sought by the eugenic program.

* * *

The eugenics program in education involves much more than courses of study; much more than the communication of basic knowledge of biology, social hygiene and demography, important as they are; it involves a fundamental philosophy of the relation of education to life and the acceptance by educators of human values and human goals that go beyond academic competence and success. As President MacCracken said, "the indirect methods of advancing the eugenic program cannot be over-emphasized. If the eugenist is to save his soul, he must first lose it."—Dr. Lawrence K. Frank, *Josiah Macy Foundation.*

Medicine and Eugenics

If we accept Galton's conception of eugenics as "the study of agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally" and if by *social control* we accept an interpretation which implies voluntary, or self-control rather than majority or compulsory dominance by law, I can see no escape from the very direct duty of physicians to study and apply to their patients within the limits of the private practice of medicine those facts which mature human experience may persuade them will encourage, release, and develop the finer potentialities of human intelligence and endeavor, and bodies more capable of biological vigor, and survival at the highest level, in terms of quality as well as length of life, through selective application of the process of human reproduction.

Furthermore, it seems to me that physicians should share in formulating and applying those compulsory sanctions found necessary within the limits of representative and civil government to forbid marriage of the unfit in body and mind and to make procreation impossible, so far as may be without offense to humane instincts, by persons whose progeny would perpetuate qualities inconsistent with individual or social happiness or security.

* * *

It is easier to tinker with a piece of junk in hand and "make it do" than to make the blue prints and forge the parts for a more competent machine.

The call of the sick, the crippled, the suffering must be met, but can easily grow so loud as to make us deaf to a symphony of the future, when life will be more a chant of the gloriously fit than a perpetual clamor for relief.

* * *

We have achieved triumphs in our command over environment, and have made such progress in the nurture of our kind that the inferior in stock, the sufferers from inherited and acquired deficiencies in structure and function are but little handicapped in competition with more fortunate fellows at the prevalent low level of life's performance. The strong, competent and well, the free in body and spirit are shackled to those whose disablements so wring our hearts that minds and spirits cannot go on to upper levels of achievement.

As Lord Horder so aptly sketched the situation, "We have forgotten heredity, which if it does not work for us, works against us. We have concentrated on nurture and neglected nature."

* * *

The infant has five times the chance to survive even through its first year than his parents had, and this in some measure by an educational experience of the mother during pregnancy. What more natural, more promising, more in the spirit of evolutionary progress in science and its application, than that we should push back the moment and point of our interest into the pre-procreational period, before the genes have made their irrevocable selections and determined a new thread of human design.

The application of eugenics for human benefit is perhaps the sounder and, if we can believe the evidence of the biologists, likely to prove the most profitable form of preventive medicine.

Commonly only when immediate necessity presses upon us do we take action and then it may be too late to avoid a catastrophe, wastage, or set-back to the march of progress. Such a period or episode in human experience appears to be upon us

The medical profession exercises, as it were, the trusteeship of society in all sciences and arts which may prevent disease and make its occurrence more bearable and less likely to shorten life. Society will do well to demand of medicine that it consecrate its treasury of resources and its good repute to the even broader and more enduring values of constructive guidance to better structure and function of man's body, to a more nearly perfect life of thought and emotion, conduct and social adaptability, and to the longest span of human life which is consistent with continuous use and happiness to the end.

No such visionary perfection can be expected unless there is a freedom for the development of both medicine and society from the dominance of personalities and policies temporarily endowed by the authority of suffrage, or the law or military power, with discretion over the lives of men.

If one were to outline the constructive and corrective, the positive and negative phases of a program of eugenics to be undertaken by the medical profession the following five might be included in an effort at upbuilding:

1. Preparation for eugenic counselling by broadening of the medical curriculum.
2. Inclusion of family pedigrees as a feature of medical records of the natural history of disease and health.
3. Encouraging of health examination of prospective mates as a basis of eugenic practice for or against procreation.
4. Countering the irrational fear of pain and hazard of maternity as exaggerated among tender-minded and abnormally self-centered women by useful promotion of confidence in the survival and well-being in childbirth of those who are fit in body and capable of devotion to the miracle of motherhood.
5. Facilitating the bearing and rearing of children of fit parents by financial concessions to those whose only hindrance or reluctance is limitation of material resources.

The following two may serve to correct tendencies towards errors of inheritance:

1. Permissive and voluntary acceptance of sterilization to stop transmissible defects of body or mind.
2. Contraceptive practice taught and demonstrated by physicians for the health benefit of mother and children as a function of private practice and with the expressed authority and encouragement of law and when necessary through government agencies of medical service.

* * *

Let us set aside a fair portion of our determination to see to it that the babe is well born, into a world free for the exercise of his entire capacity for advance of his own and his fellows' lives, without sacrifice of the lives of others as a condition of his own survival.—Haven Emerson, M.D., *Professor of Public Health College of Physicians and Surgeons.*

✦

What Is a Hybrid?

To the Editor:

DEFINITIONS of scientific terms are a matter of much fruitless debate and are often of little importance, since it is impossible to impose tight definitions on loose thinking. There are, however, a few words that are so fundamental to a science that on their precise definition its progress may largely depend. Such a word is hybrid. It began life as a term of abuse. Kölreuter used it to describe the products of experiment. Darwin hesitated to apply it to crosses within the species; Herbert, greatly daring, did so. Systematists have generally been content to use it as a label for misfits. Most would probably deny that a species can be a hybrid. Many will use "sterility" as a criterion of "hybridity" without knowing clearly what they mean by either sterility or hybridity. These discrepancies have led to others. Some theorists have ascribed evolution to the occurrence of hybrids, while others have thought that an experiment with hybrids invalidated any theory of evolution founded on it.

The Journal of Heredity should surely guide us in this matter. Yet in its glossary we find two definitions side by side. A hybrid is either "the offspring of two parents unlike one another" or it is "a heterozygote". That is to say, it is either a cross between unlike zygotes or between unlike gametes. But these definitions are contradictory. Since Mendel we know that the offspring of unlike parents may be a homozygote, and a heterozygote may be the offspring of like parents.

Amongst all this confusion Mendel's discovery prescribes the one rigorous and unequivocal definition: a hybrid is a zygote produced by the union of dissimilar gametes (or which by mutation has the character of such a zygote). Whether the gametes come from similar or dissimilar parents does not signify. There are many kinds of hybrids, depending on the dissimilarities which are now recognized in the chromosomes of the gametes. They differ in their behavior according to these dissimilarities. The gene hybrid (or heterozygote in a strict sense), the interchange hybrid, the sex hybrid, and the numerical hybrid can all be recognized in this way. Their recognition depends on observations of meiosis and on analysis of their progeny. The method of observation is cytology and the method of analysis is genetics.

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23. VI. 37.

TESTING RACES FOR THE THRESHOLD OF TASTE, WITH PTC*

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IT has been adequately shown that among members of the white race, individuals differ in their ability to detect various strengths of PTC[1-3, 7-8]. Tests have been made on various races[5-6], with the general conclusion that differences do exist among races as among individuals. The author had occasion to test 125 Whites, 202 Negroes, 29 Maya Indians and 58 Navajo Indians, with tests patterned after those designed by Dr. A. F. Blakeslee, in which paper was impregnated with different solutions of PTC, and the subject was asked to chew the papers, starting with the lowest concentration and continuing until he was sure of his taste reaction. The white subjects were members of the Carnegie Institution staff at Cold Spring Harbor; the Negroes and Indians belonged in the main to an anthropometric series which the author had measured two or three times before, hence they were somewhat acquainted with the author and his technique.

The general conclusion drawn from this testing was that races differ in their expressiveness toward the taste of PTC. This difference was so pronounced as to render the actual results of little scientific value. Most of the white tasters were very expressive when they first tasted the PTC, while Navajos, in direct contrast, would stoically chew most of the papers without a murmur, although the directions were fully understood. When we asked if they tasted the papers, we generally received an affirmative nod. Then would follow the unscientific teasing out the answer, concerning which paper he first tasted and what it tasted like. Answers such as aspirin, medicine, weeds, sage brush, cedar trees, bitter, sour and salty were obtained. Due to the extreme stolidity of the Navajo, the exact threshold was almost impossible to secure. This may have two interpretations: either that he tastes the paper, and controls his feelings, or that his taste is so dull that he is unaware of it. The author is inclined to believe that the former interpretation is true.

This leads to the matter of motivation and rapport, which is so necessary in all testing. Klineberg[4] reports that among Dakota Indians it is bad form to answer questions before someone who does not know the answer, also that they must not reply to a question unless they are absolutely sure of the answer. Now if taste tests are given to members of such a culture the true thresholds are not very likely to be secured. American Indians are wards of the government, and if a white man does the testing, the matter of rapport is quite likely not the same as when whites test whites. White people are used to taking tests, and the competitive spirit is dominant from early youth. My experience with Indians is that they would rather not be bothered. They are not interested in this type of thing. Certainly unless the complete cooperation of the subjects is gained, it is most difficult to determine the threshold of taste.

From personal experience we know that the Maya Indians are far more expressive and cooperative than the Navajos. Levine and Anderson[5] tested 183 "full-blooded Indians," but it is not told to which tribe they belonged. Among the 183 there might be members of many tribes, with different cultural backgrounds. The author believes that one should not put all Indians into one category. Similarly, it would be unscien-

*PTC = phenyl-thio-carbamide, which to the taste of most people is bitter.

tific to test white groups from South America, Europe and Australia and put the results under one heading. With these ideas in mind one wonders about the value of the study of Parr[6], when various examiners tested Arabs, Armenians, Egyptians and Chinese.

That there are racial differences the author does not doubt, but he realizes the difficulties of racial testing and the extreme delicacy of the effects of environment. For these reasons he would like to see a more objective method of measuring the intensity of the taste reaction, irrespective of the comments of the individual. At present the only method of measurement of taste reaction is the comment of the subject. Every examiner has experienced the difficulty of the subject in determining at what concentration he first tastes the substance, and in describing the taste he is experiencing. Thus the geneticist and the anthropologist solicit the cooperation of the psychologist and the physicist in securing a more objective method of measuring the reaction of the human subject to PTC.

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"NONESUCH" HAS A BIRTHDAY—AND *KITTENS*

"Nonesuch," the freak cat owned by Mrs. Annie May Gannon of Wilmington, N. C., is now a year old. Four kittens were born to this strange dog-like animal about six weeks ago. All of the kittens are perfectly normal-appearing. Two of them are spotted with black, white, and brown; a third is black and white, and the fourth is a tabby. The father of the kittens is unknown. The accompanying photographs (see cover) show three views of Nonesuch in characteristic poses, and one of her and three of her kittens.

Nonesuch has a long dog-like neck, and her head, ears, and shoulders resemble those of a fox terrier. Her sparse whiskers are short, bristly, and straight. Her entire body except for her stomach, which is as smooth as the palm of one's hand, is covered with fuzz which is black, white, and brown in color. She has a two-inch stub tail. Her hind legs are unusually long and bowed.

Nonesuch is very dog-like in her actions, in spite of the fact that she makes a noise like a cat and retracts her claws as a cat would do. When she hears a sudden, unexpected noise, she raises her right forepaw and curls it slightly under, just as a pointer would do. Nonesuch becomes alert as a dog if someone whistles for her. She stretches out her forepaws in a dog-like manner while resting. When frightened she acts very much as a dog would do in similar circumstances—her conduct, in this respect, being in marked contrast to the other members of the cat family who arch their backs when danger approaches.

In spite of all these unusual characters, Nonesuch produced a litter of perfectly normal kittens. What would the next generation show, when these kits are cats and have kittens of their own?—Henry Sternberger.

Nonesuch was described, and her genetic implications speculated on in the March, 1937, Journal. Her fortunate survival, when all her litter mates died, gives hope that we may yet arrive at a genetic understanding of the creature's peculiar appearance. The views furnished by Mr. Sternberger (see cover) prove again that she exhibits a curious complex of most uncatlike appearance with a canoid psyche.

Whether a cat without fur would look as odd might be determined by dipping a few in some of the more widely advertised depilatories. Assuming that the father of these kittens is a normal tomcat, we may guess that the "nonesuch" complex is inherited as a recessive character. Next we need interbreeding of these kittens to see whether Nonesuch's unique combination of physical and psychical abnormalities re-appears in the next generation.—Ed.

NEW COTTON VARIETIES FROM A SPECIES CROSS

Mysore Cottons and Their Improvement—I

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At the second Conference of the Empire Cotton Growing Corporation held in London in July, 1934, Dr. S. C. Harland[5] discussed the difficulty in developing commercial forms through inter-species hybridization, quoting as an example O. F. Cook's work in this regard. Trought[10] refers to a statement by Bailey who, at the 1924 meeting of the Imperial Botanical Conference, recommended that in the improvement of cotton, artificial hybridization should be left severely alone by the practical cotton breeder. Kearney[7] also supports Cook to the effect that his results from crosses of Upland and Egyptian cottons indicated small chance of developing a useful commercial variety from such a hybrid.

The above statements mostly refer to the New World cottons with 26 chromosomes. Harland, in his concluding remarks at the conference mentioned, stated: "The problem of improvement of Asiatic cottons seems to lie in the full utilization by synthesis of economic characters scattered through the *herbaceum* and *arboreum* groups." The relationship between species in the group of Old World cultivated cottons having 13 chromosomes is rather closer than among the New World species. Therefore, the chances of getting strains of practical value through inter-species hybridization in the Old World group are more hopeful.

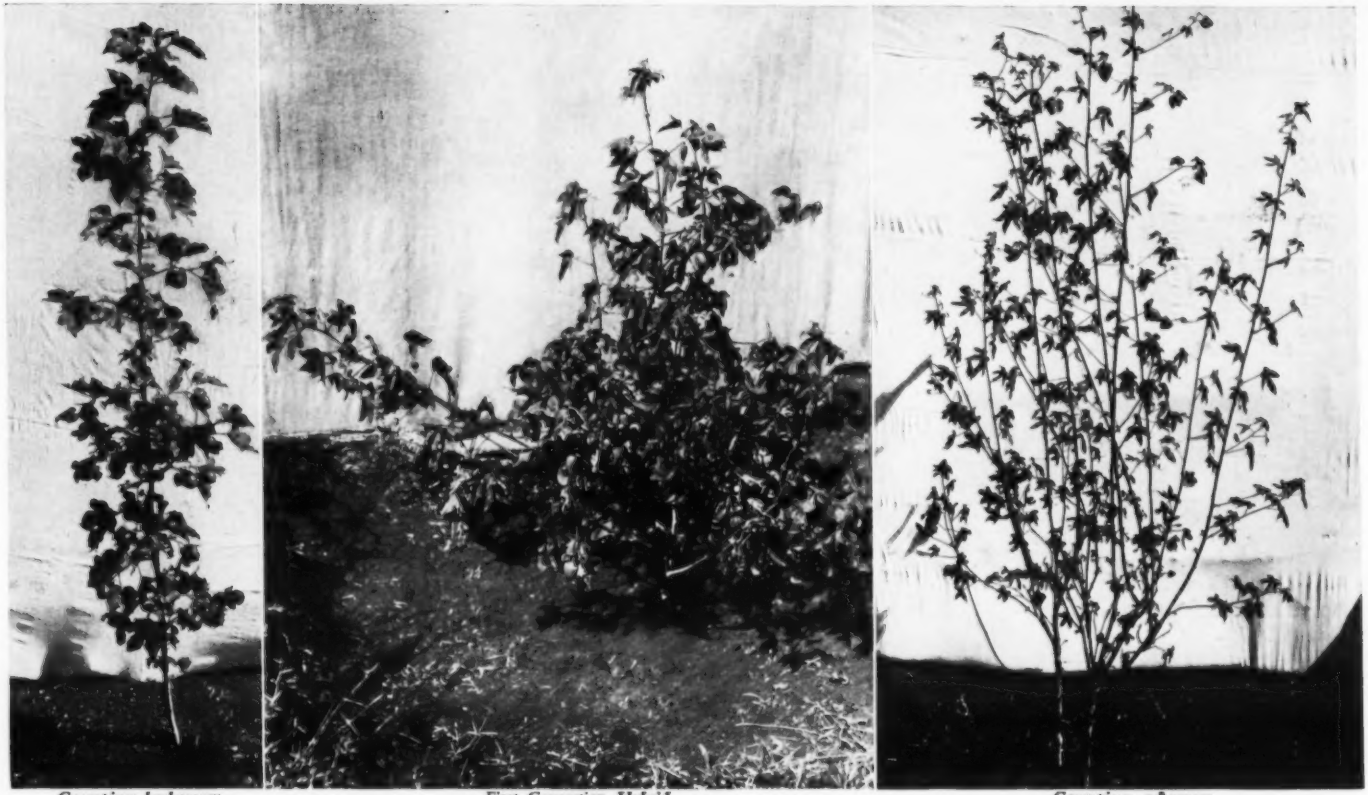
Work on a cross between *Gossypium arboreum* and *Gossypium herbaceum* (Kumpta type) has been in progress in Mysore during the last 13 years and certain practical results have been achieved. It is proposed in this paper to discuss these and the further work now in progress.

Object and Scope of the Work

A study of all the indigenous varieties grown in Mysore was made by the writer in the years 1917 to 1922[9]. As a result, several individual selections were made, a few of which proved superior to the existing local cotton. However, a difficulty was encountered in the inability to distinguish the improved strain from the locally grown mixed stocks, either in the field or at the gin, so that in a few years the improved strain had become so mixed with the local cotton that its purity could not be maintained. Hence the need arose to develop a variety of cotton which could easily be distinguished from all other cultivated cottons of the region.

It may be recalled that at one time an attempt was made to introduce Broach cotton into our area. This attempt was unsuccessful on account of the long growing period of this type of cotton, Broach being sown in June and July and harvested in February and March, whereas our cottons are sown in September and harvested in February and March. The Bombay Agricultural Department had a similar experience. It was then suggested that it might be possible to develop through hybridization a variety of cotton equal to Broach in class, staple and ginning out-turn and at the same time suitable to our conditions.

As is well known, most of the indigenous cottons of India have either broadly and shallowly lobed or narrowly and deeply lobed leaves, and either yellow or white flowers. Most of them have white seeds, but in one form the seed is black. *G. arboreum* is exceptional in having red flowers and green seeds and the leaf, although deeply lobed as in certain of our Deshi cottons, is characterized by red veins. This plant is a tree-cotton with long, white, strong lint. It is never cultivated on a large scale although Gammie quotes Hove to the effect that it was cultivated as a field crop in Gujerat. This plant is now occasionally



Gossypium herbaceum | First Generation Hybrid | *Gossypium arboreum*

A SPECIES HYBRID IN COTTON

Figure 4

Asiatic cottons are all alike in having 13 pairs of chromosomes in each plant cell, whereas New World cottons have 26 pairs of chromosomes. Fertile hybrids can readily be produced between the two main groups of Asiatic cotton,—herbaceum and arboreum,—the latter a species which grows into a small tree. (See Figure 6.) The hybrid between these forms represents a mosaic of characters from the parental species. By selection among the progeny of the second and third generation it has been possible to obtain stable forms combining desirable characteristics from both species.

found growing near temples or in the backyards of houses. If the flower color and the seed color of this plant, along with the desirable qualities of its lint, could be combined with the annual habit of our locally cultivated cottons, we should have done much to improve our indigenous varieties.*

Systematic Position of the Parents

Watt and Gammie are mainly responsible for the classification of cottons, especially of the Asiatic group. But that their systems require revision is pointed out by Leake. Watt has classified all cottons on the basis of the union or otherwise of the bracts and the color of the seed. The system is defective in that there is no place for a variety which has black seed with united bracts—*G. herbaceum* var. *melanosperma* (Gammie). Gammie's classification is very elaborate as he has increased the number of varieties based on cultivated forms.

As a result of the advance in the study of cytology of cottons and of genetic studies by Harland and Hutchinson, following Zaitzev, the Asiatic cottons are reduced to two species—(1) *Gossypium arboreum,* and (2) *Gossypium herbaceum,* with a number of varieties under each. So, it is clearly recognized that the parents of the cross described in this paper are of distinct species.

Previous Work on Hybridization with G. Arboreum

From the available evidence it appears that the first attempt to hybridize *G. arboreum* with any of the indigenous cottons was made in 1844, when, according to Watt[11], Dr. Alexander Burns of Broach crossed *G. obtusifolium* var. *Wightiana* (*G. herbaceum,* Kumpta variety) with *G. arboreum* and obtained a plant possessing the good qualities of both parents. "The leaves were those of *arboreum* * * * the flowers were red with a yellow throat and the plant cropped early and produced a very silky floss." But no further evidence regarding the performance of this cross is available, and the plant apparently died out. The next name of importance to be mentioned in connection with this work, also cited by Watt[11], is that of Major Trevor Clarke, who stated: "My most interesting cross, namely, Hinganghat by *G. arboreum* (Nurma) is thriving well and will soon flower showing that it has secured the early flowering habit of the Hinganghat parent." As in the previous case, further history of the cross is not available. Although Fyson in his paper "Some Experiments with hybridizing Indian cottons" included among his collected materials *Gossypium arboreum,* no work with this variety was done by him.

Dr. Leake[8] has done very valuable work in hybridizing this cotton, but his study was mainly confined to certain vegetative and flower characters. However, this work was continued by his assistant, Rai Saheb-Ram Prasad, who by further hybridization with *Gossypium cernuum* has developed a commercial strain called C. 402. This strain, it seems, does not possess red flowers or green seeds, nor does it come under the definition of "long-staple," as defined by Dr. Leake, which in spinning should produce counts above 25's.

As was pointed out by Mr. Fyson[2], up to the time of publication of his paper no one in India had developed a new form on Mendelian lines. The utmost that had been done was to hybridize two distinct varieties of cotton, study their behavior in a few generations and drop the work there. F. Fletcher[1] gave details of some crosses he made, but they were with reference to characters of the lint alone. The same worker later published a note in the *Journal of Agricultural Science* on "Mendelian Heredity in Cotton," in which he stated that dominance in F_1 and F_2 was shown in several characters, such as the fineness, length, and color of the lint, yellow color of the petals over white, and fuzziness over nakedness of the seeds.

*"Thus, while little is known for certain of the origin of *G. arboreum*, there seems no doubt whatever that it played an important role in the production of some of the best known cottons of the Old World." (11, p. 87.)

Description of the Parent Species

Gossypium herbaceum (Kumpta variety, Selection 69 (Figure 4), the female parent, is an annual two to four feet high, with many fruiting branches but with only one or two vegetative branches. The leaves are shallowly and broadly lobed. The corolla is yellow with a dark center and turns red in drying. The capsules are three or four celled with five to eight fuzzy seeds in each cell.

Gossypium arboretum (Figure 4), the male parent, is a tree-cotton reaching about 10 or 12 feet in height and having a very robust woody stem. The branches, which are dark red in color, ascend at an acute angle. The leaves are deeply and narrowly lobed. The corolla is dark red, drying nearly black. The seeds are green and number three to eight in each cell.

Method of Work

A cross between these species was made in 1923-24. In the first generation (Figure 4), all of the plants (about 24 in number) had a deeply and narrowly lobed leaf, red corolla with a yellow throat, and green seeds. Three characters, viz., leaf shape, flower color, and seed color were studied and eight forms were distinguished in F_2 and later generations, as follows:

1. Deeply and narrowly lobed leaf, red corolla and green seeds. (Dominant state of all three characters.)
2. Deeply and narrowly lobed leaf, red corolla and white seeds. (Dominant state of the leaf and flower characters, recessive state of the seed character.)
3. Deeply and narrowly lobed leaf, yellow corolla and white seeds. (Dominant state of the leaf character, recessive state of the flower and seed characters.)
4. Deeply and narrowly lobed leaf, yellow corolla and green seeds. (Dominant state of the leaf and seed characters, recessive state of the flower character.)
5. Shallowly and broadly lobed leaf, red corolla and green seeds. (Dominant state of the flower and seed characters, recessive state of the leaf character.)
6. Broadly and shallowly lobed leaf, red corolla and white seeds. (Dominant

A HYBRID VARIETY

Figure 5

Plant of Strain 19, which originated from an F_2 plant of the species cross.

TREE COTTON
Figure 6

The pollen parent of the cross described herewith was a species which reaches a height of 12 feet, with a stout woody stem. The red flower color and green seeds of this species are represented in the varieties produced from this cross, serving as "markers" to identify the varieties.

state of the flower character, recessive state of the leaf and seed characters.)

7. Broadly and shallowly lobed leaf, yellow corolla and green seeds. (Dominant state of the seed character, recessive state of the leaf and flower characters.)

8. Broadly and shallowly lobed leaf, yellow corolla and white seeds. (Recessive state of all three characters.)

Beginning with F_3, selections were made within these groups with respect to characters of practical utility, such as low fruiting branches, earliness, ginning out-turn (lint percentage) and quality of the lint (length, strength, and fineness). The work has been conducted in accordance with the recommendation of Trought[10], who stated: "Artificial hybridization must be considered as a means of obtaining desirable combinations in the progeny. The F_2 families must be looked on in the same light as a mixed crop from which desirable plants can be selected. The advantage of the artificial hybridization is that the mixture is more concentrated and so selection is simplified." After seven years of "conscious selection," we have in our possession several strains homozygous for the three characters studied, two of which are promising from the agricultural point of view. These are H. 190, with broadly lobed leaf, yellow corolla and green seed; and strain 19, with broadly lobed leaf, red corolla and green seed.

It may be interesting to note that from a cross between *arboreum* and *herbaceum* there was obtained a new form resembling *G. obtusifolium* which was heterozygous, splitting into *obtusifolium* and *herbaceum*. The question naturally arises as to the relation of this *obtusifolium* to either of the parents and why this form should be splitting. This is explained in a letter to the writer by Hutchinson as follows: "With regard to the relationships of the Madras obtusifoliums, I prefer to reserve judgment until I have studied them a little longer; but I am inclined to think that they are more closely related to *G. arboreum* than to *G. herbaceum*. That being so, some of your non-red, broad-leaved F_2 segregates carrying a large proportion of *arboreum* genes, would be expected to resemble *G. obtusifolium*. Since in most cases it would be heterozygous for many minor genes the appearance of *herbaceum*-like segregates among their progeny is to be expected. In my experience, a *herbaceum* gene-complex is largely recessive, so that *herbaceum*-like segregates would be expected to breed true."

Practical Significance of the Results

As was stated above, one of the two reasons for attempting this hybridization work was to develop a variety equalling Broach in quality and at the same time suitable for growing under our conditions. A comparison of the performance of this strain, namely H. 190, with the standard Broaches, viz., Surat 1027

A.L.F., and Broach Deshi 8, will show how far we have succeeded in this regard:

	Broach Deshi 8	Surat 1027 A.L.F.	H. 190
Ginning out-turn (Lint percentage)	33%	35%	30-31%
Counts spun	32's	31's	32's-35's

Mr. Hilson[6] has described an ideal plant suitable for the Bellary tract; and as the conditions in our cotton belt are practically identical with those of Bellary, such a plant would be ideal for Mysore conditions also. Hilson says: "What I am aiming at in both the tracts is to get a cotton with a staple somewhere about ⅞" or 24-25 mm in length, which will give a high yield per acre, possess a high ginning percentage, be of good quality and good class, have a good strong lint giving a test of 80 lbs. for 20's counts and also be of a good white color. The ginning percentage should be about 30%. If I can get such a cotton, I should be able to please the spinners in this country, please the exporters, please the growers, and in fact everybody. I shall not need anyone to spread the cotton; it will spread itself."

The comparison that follows shows how closely strain H. 190 conforms to Hilson's ideal.

Mr. Hilson's ideal plant.

1. Staple length ⅞" - 1".
2. High yield of kapas (seed cotton)—about 300 lbs. per acre.
3. High ginning percentage—30%.
4. Good quality and good class.
5. A good strong lint giving a test of 80 lbs. for 20's.
6. A good white colored lint.

Qualities of H. 190

Staple length is from ⅞" - 1".
High yield of kapas (seed cotton)—300 to 350 lbs. per acre.
High ginning percentage—30%.
Good quality and good class.
Good strong lint giving a test of 82-95 lbs. for 19's.
A good white color.

However, it must be remarked that strain H. 190 is highly susceptible to cotton wilt as it was never bred for wilt resistance. Selection work with a view to developing a wilt-resistant strain of this variety is in progress.

Conclusions

The object of this work, as already stated, was to develop a variety of cotton possessing red flower and green seed, to enable the grower to distinguish the strain from other cottons grown in this locality. The new variety should also equal Broach in its economic characters. Although we have in our possession one such form, Strain 19 (Figure 5), possessing a broad leaf, red flower, and green seeds and having a lint percentage of 30 per cent, its yield on a field scale is still to be determined. In the meantime, we have in H. 190 a strain derived from the same cross, which, although not red-flowered, has green seeds and thus possesses a "hall-mark" for identification in the field after the fruit opens. The fact that this strain has very good agricultural characters warrants its distribution among cotton growers.

Literature Cited

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7. Kearney, Thomas H. "Segregation and Correlation of Characters in an Upland-Egyptian Cotton Hybrid." U. S. Dept. Agr. *Bull.* 1164.
8. Leake, H. Martin. "Studies in Indian Cotton" Part I. *Jour. of Genet.* 2(3): 205-272. 1911.
9. Rao, V. N. Ranganatha. "Mysore Cottons and Their Improvement" Part I. *Trop. Agriculturist.* 63:210-213. 1924.
10. Trought, Trevor. "The Improvement of the Plant." Read at the Science Congress, Bombay, 1926.
11. Watt, Sir George. "The Wild and Cultivated Cottons of the World." 1907.

AN EARLY HORSE SKELETON

THORNTON CHARD

A HORSE'S skeleton,—the oldest to be found in Egypt—was unearthed at Thebes by the 1935-36 Expediton of the Metropolitan Museum of Art. The skeleton was discovered not far from the tomb of Sen Mût who was chief favorite of Queen Hatshepsût; the architect of her temples; the guardian of her daughter; and one who played a very influential part early in the 15th Century B. C.[1]

The circumstances of finding the skeleton are as follows: "Removal of the chip and large boulders packed on the floor of the gully soon brought to light an enormous coffin. — It was no less than seven and a half feet long and was made, as mortises and dowel holes showed, out of old wood. We assumed that it was an outer coffin used merely as a protection for a finer coffin inside, but when the lid was removed we had a surprise. It was the burial of a horse. Now the horse was, in the time of Sen Mût, a recent importation from Asia into Egypt, and it is natural that anyone who owned a horse would have prized an animal so spirited as compared with the lowly donkey, which up to that time had been the only animal of the sort in Egypt.[2]

"The horse had been wrapped up in linen just as though it were a human being, but no signs of mummification were noted. On its back among the wrappings was what may be considered the first saddle known to us. It is more like a saddle cloth, to be sure, being merely a rectangular piece of linen and leather with a projection toward the rear. Tapes attached to the forward end were tied about the horse's neck, and two longer tapes at the other corners formed a girth. The underside of the saddle was reinforced and at the same time decorated by another tape with an intricately woven colored pattern. We know from the papyri and from paintings and inscriptions in tombs and temples that the Egyptians had many horses from the XVIII Dynasty onward, but hitherto no skeleton of so early a date has been discovered."[2]

The Director of the Egyptian Expedition, Mr. Ambrose Lansing, has gone to a great deal of pains to obtain for me information that permits a general comparison wth a modern Arabian horse skeleton and helps to determine the controversial point of the origin of the Egyptian horse. This information consists of measurements of various parts of the skeleton made by Brunton and Keimer* and reports and a height estimate made by Dr. D. E. Derry† and Dr. B. Boulgakow who examined and repaired the bones.

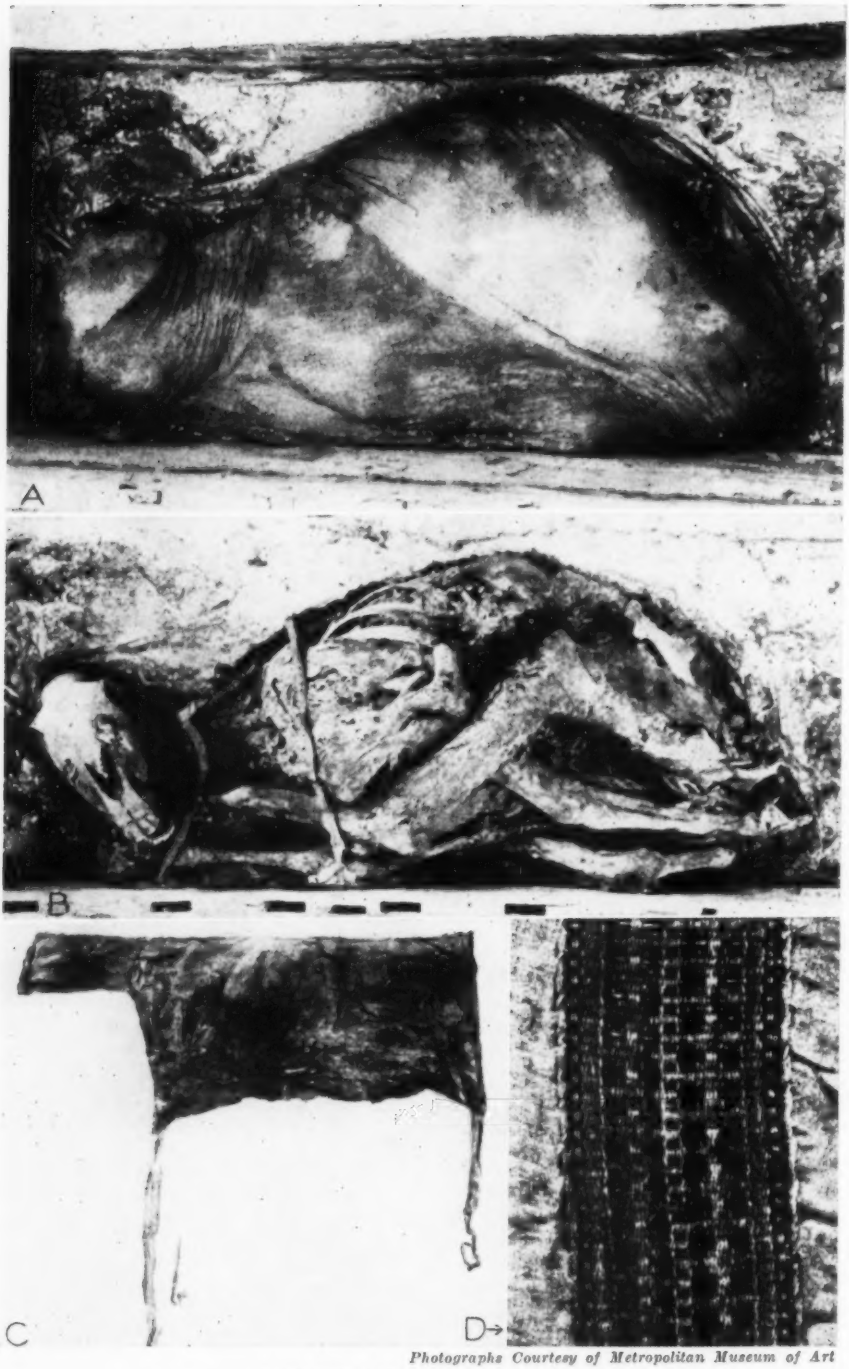
Dr. Derry estimates "the height of the horse," figured proportionately from the length of a fore leg, "at 12½ hands (50 inches) but it is only an estimate." He further reports that "the animal is believed to be a mare about five or six years of age at the time of death;" and that water had rotted some of the bones including parts of the skull which, unfortunately, fell to pieces on being unpacked.

This was, indeed, unfortunate because the skull is the most persistent trait in all animal species and in this case might have afforded additional significant measurements.

However, some small measurements were finally obtained although not that of the total length. These and other measurements together with photographs taken before the removal of the skeleton, were submitted by the Arabian horse breeder, Mr. W. R. Brown, and by me

*Guy Brunton, Assistant Keeper of the Cairo Museum. Dr. Keimer, Director of the Agricultural Museum.

†Professor D. E. Derry of the Anatomical Section of the Faculty of Medicine of the Egyptian University.



Photographs Courtesy of Metropolitan Museum of Art

EARLIEST EGYPTIAN HORSE

Figure 7

See legend on next page.

to Mr. S. H. Chubb, the osteology expert of the American Museum of Natural History, who reported to Mr. Brown ". . . that with the exception of the statement that the 'skull is long' I will say that . . . [the] measurements and description very strongly suggest the Arabian type. Perhaps the most definite and the strongest point is the proper vertebrae formula."

The details of this vertebrae formula are: cervical 7; ribbed 18; *lumbar 5;* sacrum 5; and tail 14 which latter number, according to Mr. Chubb, varies between 14 and 16; but in this skeleton it is 14, making he total number of vertebrae 49.

In a conversation with Mr. Chubb, in his laboratory, where we had before us several modern Arabian skulls and the photograph of the Egyptian skull, he said that the general appearance of the Egyptian skull was that of an Arabian.

The estimated height of this horse as given by Dr. Derry would be that of a very small horse, for, while some Bedouin tribes breed excellent horses not higher than 13½ hands (54 inches), the average height of the modern desert-bred Arabian is 14½ hands (58 inches) which average, it is safe to say, has not varied greatly for centuries. Nevertheless, history and archaeology[3] point to Arabia as the source of the Egyptian horse.

If ancient drawings may be relied upon to give the relative height of men and horse, we may conclude that this skeleton horse was higher rather than lower than the contemporaries and of a less height than Arabian horses of some centuries later, because, in tombs 84 and 100 at Thebes were found drawings, showing Syrians bringing tribute of horses to the Egyptians of the XVIII Dynasty, in which three horses are outlined that certainly do not stand above 10½ hands (42 inches) in height.[4]

Literature Cited

1. Section II of the Bulletin of the Metropolitan Museum of Art, New York, Jan., 1937, p. 3.

2. *Ibid,* pp. 8, 10, 11.

3. Wolfgang Amschler, *Journal of Heredity,* vol. 26, no. 6.

4. Section II of the Bulletin of the Metropolitan Museum of Art for December, 1930, opp. p. 38.

(Legend to Figure 7)

An elaborately buried horse, found at Thebes in 1936, represents the earliest evidence of the horse in Egypt,—where before that time the humble donkey served to carry equestrian burdens. This burial dates to about 15 centuries before Christ. In several characteristics it seems to resemble closely the Arabian horse of today, indicating how ancient is that most valuable equine strain.

The above photographs show details of the horse burial. *A*—The skeleton in its wrappings of linen cloth. *B*—The skeleton exposed. No mummification is evident, thought the skeleton is wrapped in the manner customary in human burials of that time. *C* shows the oldest Egyptian saddle, a pad with a surcingle strap. *D* shows a detail of the tape of which the strap is made, showing the fine weaving performed on this first Egyptian saddle of which there is record.

◆

Government Needs Biologists

The U. S. Civil Service Commission announces unassembled examinations (Nos. 76 and 79) for Principal Animal Husbandman ($5,600 a year), Bureau of Animal Industry, and for Associate and Assistant Botanists $3,200 and $2,600 per year), Bureau of Plant Industry. Applications must be on file by October 25 for the former and by October 18 for the latter. The details may be obtained from the U. S. Civil Service Commission, Washington, D. C.

A SUMMARY OF LETHAL CHARACTERS IN ANIMALS AND MAN

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THE term "lethal factor" is usually understood as a factor causing the death of the organism in which it occurs, either during prenatal life or at birth. In a broader sense, lethal may be defined as a factor which, because of certain defects which it produces, eventually leads to the death of the organism. Such cases are sometimes called semi-lethals. A more recent interpretation classes as lethal, factors which cause death to certain portions of the organism, as nerves, but not necessarily to the organism as a whole. (Stockard[8].)

Many of the defects now classed as a result of lethal genes have long been known and described as anatomical monstrosities, but their connection with the science and phenomena of heredity is of recent development. Explanation of lethal factors apparently originated in the field of botany in the explanations by Correns[2] and Baur[1] of exceptions in Mendelian ratios in corn and snapdragon (Antirrhinum) respectively.

In the field of zoology exceptions to Mendelian expectation in breeding yellow mice were first reported in 1905 by Cuénot[3]. In 1910 Quackenbush[6] reported similar phenomena with Drosophila. Since 1912 Morgan and many other workers with Drosophila have reported and explained numerous lethal mutations in this species, and at present more than 150 have been reported[7]. The lethal theory for the explanation of abberant sex ratios in yellow mice was not confirmed until 1917 by the embryological studies of Kirkham[5], and by those of Ibsen and Steigler[4]. Since this time numerous cases of lethals have been reported for various species of domestic animals and man.

In the present summary of lethal factors in animals and man an attempt has been made to cite the first reference to the character in question, and subsequent references which have contributed to the understanding of is heredity. Doubtless many other references have been overlooked. The animals dealt with have been separated according to species, and the lethal factors with a brief description of their phenotypic effects and mode of inheritance follows. Some reported as distinct types undoubtedly should be classified with other similar defects, but insufficient knowledge at the present time makes accuracy of classification impossible in many cases. In many cases which are recognized as heritable the exact mode of inheritance cannot be stated because of lack of sufficient evidence, and in some cases, the mode of inheritance may prove, on further analysis, to be more complicated than is at present indicated. It will be noted that some defects of a similar nature are found in several species.

SUMMARY OF LETHAL CHARACTERS

Principal Farm Animals

Cattle

Achondroplasia$_1$ (Bull-dog calves): Short legs, short thick head, often hernia. Usually aborted during fourth month of pregnancy. Dominant. Reported in Dexter and in African cattle.

WILSON, J. *Proc. Roy. Dublin Soc. N. S.* 12: 1-17. 1909-1910.

CREW, F. A. E. *Proc. Roy. Soc. Med.* 17: 39-58. 1924.

CARMICHAEL, J. *Nature.* 131: 878. 1933.

Achondroplasia$_2$ (Bull-dog calves): Strong achondroplasia, short head, cleft palate, deformed jaws. Die a few days after birth. Single recessive. Reported in Telemark and Holstein cattle.

Mohr, O. L., and Chr. Wriedt. *Zeitschr. f. Tierz. u. Züchtungsbiol.* 3:223-230. 1925.

Mohr, O. L. *Zeitschr. f. indukt. Abstam. u. Vererbungsl.* 41:59-109. 1926.

Weinkopf, P. *Berliner Tierärztl. Wochenschr.* 43:62-63. 1927.

Acroteriasis congenita (Amputated): Absence of all appendages, or developed only to elbows and hocks. Atrophy of upper jaw, almost complete absence of lower jaw, cleft palate. Stillborn or die shortly after birth. Single recessive. Reported in Swedish Holsteins.

Wriedt, Chr., and O. L. Mohr. *Jour. Genet.* 20:187-215. 1928.

Ankylosis: Ossification of the articulation of the lower jaw, jaw shortened. Recessive. Reported in Norwegian Lyngdal cattle.

Mohr, O. L. *Naturens Verden* 14:1-31. 1930.

Ossification of all joints. Associated with cleft palate. Probably single recessive. Reported in German cattle, in an address by V. Stang, Berliner Tierärztl. Gesell. Sitzung Dec. 2, 1935.

Referred to by Schäper, W. *Zeitsch. f. Züchtung B.* 35:1-88. 1936.

Congenital dropsy: Accumulation of water in the subcutaneous tissues and in the thoracic and abdominal cavities, especially abundant in head and neck region. Born at term or one to two months prematurely. Probably single recessive. Reported in black and white Swedish Lowland cattle.

Larsson, E. L. Lantbr. Veck. Handl. pp. 310-331. 1935.

Congenital ichthyosis: Various abnormal conditions of the skin; scaly and cracked; perhaps allied with epitheliogenesis imperfecta. Recessive.

Lesser, E. Lehrb. der Haut-u. Geschlecht-Krankh. 13 Aufl. Berlin. 1914.

Epitheliogenesis imperfecta: Defective skin on the lower legs and the mucous membranes of the mouth and nostrils, deformed ears and claws, large hairless patches over body. Born at term but die from septicaemia as a result of bacterial invasion. Single recessive. Reported in Holsteins in the U. S. and Holland and in Jersey cattle in the U. S.

Cole, L. J. *Jour. Hered.* 10:303-306. 1919

Hadley, F. B., and L. J. Cole. *Wis. Agr. Exp. Sta. Res. Bul.* 86. 1923.

Hadley, F. B. *Jour. Hered.* 18:487-495. 1927.

Hadley, F. B., and B. L. Warwick. *Jour. Am. Vet. Med. Assoc.* 70:492-504. 1927.

Regan, W. M., S. W. Mead, and P. W. Gregory. *Jour. Hered.* 26:357-362. 1935.

Wipprecht, C., and W. R. Horlacher. *Jour. Hered.* 26:363-368. 1935.

Foetal resorption: Various stages from decomposed masses to only bones or dried mummies. Mode of inheritance not definitely known.

Turner, C. W. *N. Amer. Vet.* 8(11):27-31. 1927.

Hypotrichosis congenita (Hairless): Hair only on the muzzle, eyelids, ears, pasterns, and end of tail. Calves die a few minutes after birth. Single recessive. Reported in Swedish Holsteins.

Mohr, O. L., and Chr. Wriedt. *Jour. Genet.* 19:315-336. 1927.

Butz, H. *Deutsch. Tierärtzl. Wochenschr.* 42:653-658. 1934.

Eisele, F. *Züchtungskunde* 11:432-437. 1936.

Impacted molars: Reported in Milking Shorthorns. Mandible shortened, premolars impacted in jaw, causing lateral surface to bulge or break. Molar germs irregularly placed and reduced. Calves born at term, die during first week.

Heizer, Edwin E., and Marshall C. Hervey. *Jour. Hered.* 28:123-128. 1937.

Muscle contracture: Head bent backwards, neck stiff, front and hind legs drawn together toward body, joints rigid. Single recessive. Reported in Norwegian and Holstein cattle.

Mohr, O. L. *Naturens Verden.* 14:1-31. 1930.

Hutt, F. B. *Jour. Hered.* 25:41-46. 1934.

Hind legs lame, calves cannot stand and do not remain alive very long. Probably single recessive. Reported in Red Danish cattle.

Loje, K. *Tidsskrift. f. Landokonomi* 10:517-549. 1930.

Mummification: Foetuses die at eighth month of gestation. Have short neck, stiff legs, and prominent joints. Recessive. Reported in Red Danish cat-

tle. Possibly allied with foetal resorption and muscle contracture.

LOJE, K. *Tidsskrift. f. Landokonomi* 10:517-549. 1930.

Short-limbs: Limbs short and hoofs undeveloped. Usually aborted prematurely. Single recessive. Reported in Swiss cattle in Russia.

LJUTIKOW, K. *Jour. of Biol.* 1:21-51. 1932.

Short spine: Axial skeleton much shortened, ribs and vertebrae fused. Stillborn or die at birth. Single recessive. Reported in Norwegian mountain cattle.

MOHR, O. L., and CHR. WRIEDT. *Jour. Genet.* 22:279-297. 1930.

Horses

Atresia coli (Closure of intestine): Ascending colon greatly constricted or ends blindly. Often associated with brain tumor. Colts die in two to four days. Single recessive.

YAMANE, J. Trans. 6th Cong. Far East. Assoc. Trop. Med. 815-818. 1925.
NUSSHAG, W. *Berl. Tierärztl. Wochenschr.* 41:646-648. 1925.
YAMANE, J. *Zietschr. f. indukt. Abstam. u. Vererbungsl.* 46:188-207. 1927.

Abnormal sex ratio: About one-half of the males die in utero; ratios of 55 males to 90 females are reported. Sex-linked recessive.

KISSLOWSKI, D. *Zeitschr. f. Tierz. u. Züchtungsbiol.* 24:269-279. 1932.

Lethal white: Low fertility in white horses of the Frederiksborg stud. Lethal factors, or sterility factors, or both.

WRIEDT, CHR. *Zeitschr. f. Tierz. u. Züchtungsbiol.* 1:231-242. 1924.

Stiff forelegs: Probably recessive.

SCHÄPER, W. *Tierärztl. Rundschau* 41:85-89. 1935.

Cannot stand and normally die, 8 crippled to 18 normal in matings of animals carrying the gene. Probably a gene deficiency or the loss of one of an allelomorphic pair, causing it to act as a dominant.

PRAWOCHENSKI, R. *Jour. Hered.* 27:411-414. 1936.

Sheep

Amputated: Absence of claws on all four feet. Mode of inheritance not determined. Reported in sheep in Holland.

KROON, H. M., and G. M. VAN DER PLANCK. *Tijdschr. v. Diergeneeskd.* 58:681-694. 1931.

Earless and cleft palate: No ears, cleft palate, short ankylosed lower jaw, tri-partite claws. Single recessive. Reported in sheep in Norway.

MOHR, O. L. *Züchtungskunde* 4:105-125. 1929.

Lethal gray: Homozygous gray lambs die. Recessive. Reported in Turkana sheep of Roumania and in Karakul sheep in Russia. Probably same as foetal mortality reported by Hammond.

HAMMOND, J. *J. Agr. Sci.* 11:337-367. 1921.
CONSTANTINESCU, G. K. *Ann. Inst. Nat. Zootechn. de Roumanie* 1:15-28. 1932.
GLEMBOCKII, JA. L. *Biol. Z. Mosk.* 4:355-362. 1935.

Muscle contracture: Stiff joints of the lower legs, crooked neck. Hip and shoulder joints free. Usually stillborn. Recessive. Reported in Welsh mountain sheep and others.

ROBERTS, J. A. F. *Jour. Minist. Agr.* 33: 795-801. 1926.
———. *Jour. Genet.* 21:57-70. 1929.

Paralysis: Hind legs paralyzed, lambs can stand only with difficulty, born alive, but die in a few days. Recessive.

CREW, F. A. E. *Proc. Roy. Soc. Med.* 17: 39-58. 1924.
ZOPHONIASSON, P. *Nord. Yurdbrugsforsökning Kopenhagen.* 11:327-330. 1929.

Skeletal defects: Body short and thick, skull large, upper jaw short, rigid fetlocks, wool short and absent from brisket to anus. Born alive, but soon die. Single recessive. Reported in Iceland sheep.

ZOPHONIASSON, P. *Nord. Yordbrugsforsökning Kopenhagen.* 11:327-330. 1929.

Swine

Atresia ani: Partial or complete closure of the anus, or a blind opening into the colon. Born alive but soon die. Probably complex in inheritance.

KINZELBACH, W. *Zeitschr. f. indukt. Abstam. u. Vererbungsl.* 60:84-124. 1931.

"Catlin mark": Opening between

parietal or frontal bones. Die within an hour after birth. Single recessive.

GOLDSMITH, WM. *Jour. Hered.* 13:69-71. 1922.
NORDBY, J. E. *Jour. Hered.* 20:229-232. 1929.
HUGHES, E. H., and H. HART. *Jour. Hered.* 25:111-115. 1934.

Cleft palate: Young unable to nurse and soon die. Recessive.

MCPHEE, H. C., E. Z. RUSSELL, and J. ZELLER. *Jour. Hered.* 22:393-403. 1931.

Excessive fatness: Young die at 40 to 80 kg. weight from abnormal fatness. Probably recessive.

SCHÄPER, W. *Zeitschr. f. Schweinez.* 42: 723-727. 1935.

Foetal mortality: Embryos die during embryonic life. Associated with an inherent inability to utilize certain vitamins and salts. Probably recessive.

HAMMOND, J. *J. Agr. Sci.* 6:262-277. 1914.
———. *J. Agr. Sci.* 11:337-366. 1921.
CORNER, G. W. *Am. J. Anat.* 31:523-545. 1923.

Hypotrichosis (Hairless): Very sensitive skin, die at birth. Due to iodine deficiency. Corrected by feeding iodine. Tendency of inability to metabolise iodine may be inherited.

HART, E. B., and H. STEENBOCK. *J. Biol. Chem.* 33:313-323. 1918.

Muscle contracture: Stiff forelegs, usually born dead or die soon after birth. Single recessive. Probably same as thickened forelegs, which is caused by a gelatinous infiltration of connective tissue near the bones.

WALTHER, A. R., J. PRÜFER, and P. CARSTENS. *Der Züchter* 7:178-184. 1932.
HALLQUIST, C. *Hereditas* 18:219-224. 1933.

Paralysis: Complete paralysis of the hind legs. Single recessive.

MOHR, O. L. *Naturens Verdens* 14:1-31. 1930.

Poultry

Abnormal upper mandible: Maxillae absent or reduced, nasals reduced, beak bent to one side, rarely hatch. Recessive.

ASMUNDSON, V. S. *Jour. Hered.* 27:401-404. 1936.

Chondrodystrophy: Foetal deformation of bones and joints, not related to other types of foetal malposition. Probably a recessive involving three pairs of factors.

DUNN, L. C. *Arch. Entwicklungsmech.* 110: 341-365. 1927.
HUTT, F. B., and A. W. GREENWOOD. *Proc. Roy. Soc. Edinburgh* 49:145-155. 1929.
UPP, C. W. *La. Sta. Bul.* 255. 1934.

Congenital loco: Not able to stand, bent back head, 88 per cent die within a month. Single recessive.

KNOWLTON, F. L. *Ore. Exp. Sta. Bul.* 253. 1929.
HUTT, F. B., and G. P. CHILD. *Jour. Hered.* 25:341-350. 1934.

Creeper: Short legs and wings, both somewhat deformed. Homozygotes die the fourth day of incubation. Dominant.

CUTLER, J. E. *Jour. Hered.* 16:353-356. 1925.
DUNN, L. C., and W. LANDAUER. *Am. Nat.* 60:574-575. 1926.
LANDAUER, W., and L. C. DUNN. *Jour. Genet.* 23:397-413. 1930.
LANDAUER, W. *Jour. Genet.* 25:367-394. 1932.
DAVID, P. R. *Wilhelm Roux Arch. f. Entwickl. mech. der Organism.* 135:521-551. 1936.

Dwarf: Dwarfs die when homozygous. Simple recessive. In Rhode Island Reds and other breeds.

LANDAUER, W. *Am. Jour. Anat.* 43:1-44. 1929.
MAYHEW, P. L., and C. W. UPP. *Jour. Hered.* 23:269-276. 1932.
UPP, C. W. *Poultry Sci.* 11:370-371. 1932.
———. *Poultry Sci.* 13:157-165. 1934.

Embryonic lethals: Abnormalities of various types, often due to breeding. Prevent the chicks from hatching. Probably varied in mode of inheritance.

UPP, C. W. *La. Sta. Univ. Bul.* 255. 1934.

Flightless: Broken flight feathers, deformed beak, absence of feathers in varying degrees. Slightly abnormal hatching ratios. Probably recessive.

WARREN, D. C. *Jour. Hered.* 28:17-18. 1937.

Malposition of embryos: Causes death before hatching; death may occur up to the twenty-first day in various types. Mode of inheritance not determined.

HUTT, F. B. *Proc. Roy. Soc. Edinburgh* 49: 118-130. 1929.

HUTT, F. B., and J. R. CAVERS. *Poultry Sci.* 10(7):403-404. 1931.

Recessive white: Homozygous whites die. Recessive. Reported in White Wyandottes.

DUNN, L. C. *Am. Nat.* 57:345-349. 1923.

Reported in S. C. White Leghorns with abnormal sex ratios of one dead male to two dead females. Sex linked recessive.

UPP, C. W., and N. F. WATERS. *Poultry Sci.* 14:372 and 379. 1935.

Short legs: Die toward end of incubation period, perhaps associated with creeper. Lethal when homozygous. Reported in Dark Cornish.

LANDAUER, W. *Jour. Genet.* 31:237-242. 1935.

Sticky embryo: Sticky liquids present at hatching time, preventing chicks from hatching. The allantoic and amniotic fluids are not absorbed. Simple recessive.

BYERLY, T. C., and M. A. JULL. *J. Exp. Zool.* 62:489-498. 1932.

Crested (ducks): Extreme cerebral hernia, upper beak reduced, die when nearly ready to hatch. Incomplete dominant.

RÜST, W. *Arch. f. Geflügelkunde* 6:110-116. 1932.

Miscellaneous Animals

Canary Bird

Lethal white: Birds homozygous for white and crested die. Dominant.

DUNCKER, H. *Jour. Ornith.* 71:421-451. 1923.
———. *Jour. Ornith.* 72:314-379. 1924.

Cat

Lethal white: Embryos of homozygous whites die in utero. Recessive.

JONES, E. E. *Jour. Hered.* 13:237-239. 1922.

Dog

Cleft palate: Die because of inability to nurse. Reported in Bulldogs. Recessive.

WRIEDT, CHR. *Zeitschr. f. Tierz. u. Züchtungsbiol.* 3:223-230. 1925.

Hypotrichosis (Hairless): Born alive but soon die. Often with deformed face. Dominant.

LETARD, E. *Compt. rend. Soc. Biol.* 103:1135-1136. 1930.
———. *Revue Vétérinaire* 82:553-571. 1930.

Lethal white: Irregular gray spots on a white ground. Homozygous puppies are abnormal, weak, unable to run, and often deaf and show eye defects. Rarely survive. Recessive.

WRIEDT, CHR. *Norsk Kennelkl. Tidsskr.* 20: 25-34. 1919.

Paralysis: Death of the motor and preganglionic sympathetic neurones in the lateral and anterior horns of the lumbar region of the spinal cord, taking place 8 to 14 weeks after birth. The animal does not necessarily die. Reported in Great Dane and St. Bernard and Dane and Bloodhound crosses. Multiple factor dominant involving at least three genes.

STOCKARD, C. R. *Am. J. Anat.* 59:1-53. 1936.

Guinea Pig

Congenital palsy: Unable to control movements, usually die at about two weeks of age. Recessive.

COLE, L. J., and H. L. IBSEN. *Am. Nat.* 54: 130-151. 1920.

Otocephaly: Various degrees of head and ear abnormalities. Complex inheritance, probably multiple genes involved.

WRIGHT, S., and O. N. EATON. *J. Agr. Res.* 26:161-182. 1923.
WRIGHT, S. *Genetics* 19:471-505. 1934.

Polydactyl: Numerous toes present, homozygous young die in embryonic life or at birth. Other deformities often present. Complex inheritance.

WRIGHT, S. *Jour. Hered.* 25:359-362. 1934.
———. *Genetics* 20:84-107. 1935.

A lethal in crosses of Cavia aperea by C. cobaya: In F_2 stock carrying albinism, the ratio of colored to albino was 2:1. Colored animals of the formula $C^L\ C^L$ fail to develop.

PICTET, ARNOLD. *Compt. rend. Soc. Phys. et d'Histoire nat. Genève.* 53:36-39. 1936.

Mouse

Anemia (Lethal white): Homozygous whites die in utero, or when born alive

are weaklings and unable to utilize milk. Blood low in hemoglobin. Die in about seven days. Injection of normal blood corrects the deficiency. Recessive.

LITTLE, C. C. *Am. Nat.* 49:449-458. 1915.
———. *Am. Nat.* 53:185-187. 1919.
DETLEFSEN, J. A. *Anat. Rec.* 24:417. 1923.
DE ABERLE, S. B. *Am. Nat.* 59:327-335. 1925.
GOWEN, J. W., and E. H. GAY. *Am. Nat.* 66: 289-300. 1932.

Anury (tailless)

Brachyury (semi-tailless) :These two defects are apparently varying degrees of one abnormality, varying from only a slight shortening of the tail to complete absence of the tail. Homozygotes die in utero about tenth day of embryonic development. Reported by various investigators as both dominant and recessive.

ZAVADSKAIA, N. *Compt. rend. Soc. Biol.* 97: 114-119. 1927.
ZAVADSKAIA, N., and N. KOBOZIEFF. *Compt. rend. Acad. Sci.* 191:325-355. 1930.
CHESLEY, P. *Proc. Soc. Exp. Biol. and Med.* 29:437-438. 1932.
EPHRUSSI, M. B. *Compt. rend. des Séances de l'Acad. des Sci. Paris.* 197:96-98. 1933.
CLARK, F. H. *Proc. Nat. Acad. Sci.* 20:276-279. 1934.
ZAVADSKAIA, N., and S. VERETENNIKOFF. *Arch. de Zool. exp.* 76:249-358. 1934.
EPHRUSSI, B. *J. Exp. Zool.* 70:197-204. 1935.
KOBOZIEFF, N. *Bull. biol.* 69:265-408. 1935.
CHESLEY, P., and L. C. DUNN. *Genetics* 21: 525-536. 1936.

Gray lethal: Growth slows up the second week and the young die at 22 to 30 days of age. No teeth. Recessive.

GRÜNEBERG, H. *Jour. Hered.* 27:105-109. 1936.

Harelip: Cleft palate and harelip, young unable to nurse. Recessive.

REED, S. C., and G. D. SNELL. *Anat. Rec.* 51: 43-50. 1931.
REED, S. C. *Anat. Rec.* 56:101-110. 1933.

Head deformities: Eyeless, earless, and hydrocephalic. Probably allied to hydrocephalus.

LITTLE, C. C., and H. J. BAGG. *J. Exp. Zool.* 41:45-91. 1924.

Hydrocephalus$_1$: Pressure of the cerebro-spinal fluid on the brain, causing bulging head. Homozygotes rarely live. Recessive.

CLARK, F. H. *Proc. Nat. Acad. Sci.* 18:654-656. 1932.
———. *Proc. Nat. Acad. Sci.* 21:150-152. 1935.

Hydrocephalus$_2$: Affected individuals may live to sexual maturity but are sterile. Recessive.

ZIMMERMAN, K. *Zeitschr. f. ind. Abstam. u. Vererbungsl.* 64:176-180. 1933.

Parted frontals: Opening between frontal bones. Dominant.

KEELER, C. E. *Jour. Hered.* 21:19-20, 21:83. 1930.

Tremor (Reported in Peromyscus): Trembling limbs, deficient growth, die before five weeks of age. Recessive.

HUESTIS, R. R., and E. BARTO. *Jour. Hered.* 27:436-438. 1936.

Waltzing: Japanese waltzing mice show abnormal sex ratios which may be the effect of lethal genes. Recessive and sex linked.

LITTLE, C. C. *Am. Nat.* 54:457-460. 1920.

Yellow: Homozygous yellows die in utero. Dominant.

CUÉNOT, L. *Arch. de Zool. exp. gén.* 3:123-132. 1905.
———. *Arch de Zool. exp. gén.* 9:7-15. 1908.
CASTLE, W. E., and C. C. LITTLE. *Science N.S.* 32:868-870. 1910.
IBSEN, H. L., and E. STEIGLER. *Am. Nat.* 51: 740-752. 1917.
KIRKHAM, W. B. *Anat. Rec.* 11:480-481. 1917.
———. *J. Exp. Zool.* 28:125-135. 1919.

Rabbit

Dwarf: Homozygotes die, probably because of endocrine abnormalities. Complex inheritance.

GREENE, H. S. N., C. K. HU, and W. H. BROWN. *Science* 79:487-488. 1934.

Hypotrichosis (Naked, hairless): Hairless and defective teeth, die within a month. Recessive.

KISLOWSKY, D. *Jour. Hered.* 19:438-439. 1928.

Prognathism (protruding lower jaw: Protrusion of jaw causes abnormal elongation of incisers, making it impossible for the animal to eat, thus dying of starvation. Probably dominant.

NACHTSHEIM, H. VI. Weltgeflügelkongress, Berlin-Leipzig. pp. 110-115. 1936.

Shaking paralysis: Trembling and paralysis of the hind legs. Animal becomes emaciated and dies at three to four months of age. Recessive.

NACHTSHEIM, H. *Der Erbarzt.* 1:36-38. 1934.

Rat

Inanition: Young die during second week after birth, apparently from lack of food. Recessive.

CREW, F. A. E. ,and S. K. KOU. *Jour. Genet.* 28:25-31. 1933.

Man

Brachyphalangy: Short middle phalanx of the second finger and toe. When homozygous, body much deformed, no fingers or toes, live only about one year. Dominant.

MOHR, O. L., and CHR. WRIEDT. Carnegie Inst. Washington Pub. 295. 1919.

Congenital ichthyosis: Cracking and separation of the skin into large scaly sections, often red or bleeding. Homozygotes are aborted or born prematurely. Those born at term die in about three days. Recessive.

RIECKE, E. *Arch. f. Derm. u. Syph.* 54:289-340. 1900.

Glioma retinae: A malignant tumor causing blindness and eventually death unless operated for. Starts during the first year or in utero. Heredity not determined.

GRIFFITH, A. H. *Brit. Jour. Ophth.* 1:529-532. 1917.

TRAQUAR, H. M. *Brit. Jour. Ophth.* 3:21-22. 1919.

Icterus: Very recently there has appeared [*Jour. Amer. Med. Assoc.* 108 (25):2151, 1937] a report by Péhû, Noel and Brochier at the March 28 meeting of the Acad. de méd. de Paris, of a family of five children of which four had icterus (jaundice) at birth or within a short time afterwards. Two died (at 4 days and 3½ years); two others recovered following intragluteal injections of citrated blood. Recovery from this disease is reported as very rare. This appears to be another inherited lethal.

Infantile amaurotic idiocy: Degeneration of the nerves of the cerebro-spinal axis, causing death at two to three years of age. Degeneration starts during the first year. Recessive.

FELDMANN, J. *Klin. Monatsbl. f. Augenheilk.* 63:641-653. 1919.

V. STARCK. *Monatsschr. f. Kinderheilk.* 18: 139-141. 1920.

SCHAFFER, K. *Arch. f. Psychiat. u. Nervenkrankh.* 64:570-616. 1922.

SIEMENS, H. W. Einführ. in die allgemein. u. Spez. Vererbungspath. des Mensch. Berlin. 1923.

Progressive spinal muscular atrophy: Progressive wasting of the muscles with paralysis due to degeneration of the ventral gray horns of the spinal cord and the anterior nerve roots and muscles. Causes death in early childhood. Considered hereditary.

BERNHARDT, M. *Virch. Archiv.* 115:197-216. 1889.

WERDNIG, G. *Arch. f. Psychiatrie* 22:437-480. 1890-1891.

HOFFMANN, J. *Deutsch. Zeitschr. f. Nervenheilk.* 3:427-470. 1893.

———. *Deutsch. Zeitschr. f. Nervenheilk* 10:292-320. 1897.

MARBURG, O. M. Lewandowsky's Handb. der Neurologie. Berlin. 2:287-288. 1911.

Xeroderma pigmentosum: Skin very sensitive to sunlight, producing erythema and pigmented scars, and often carcinoma. Usually causes death before twelfth year of life. Recessive.

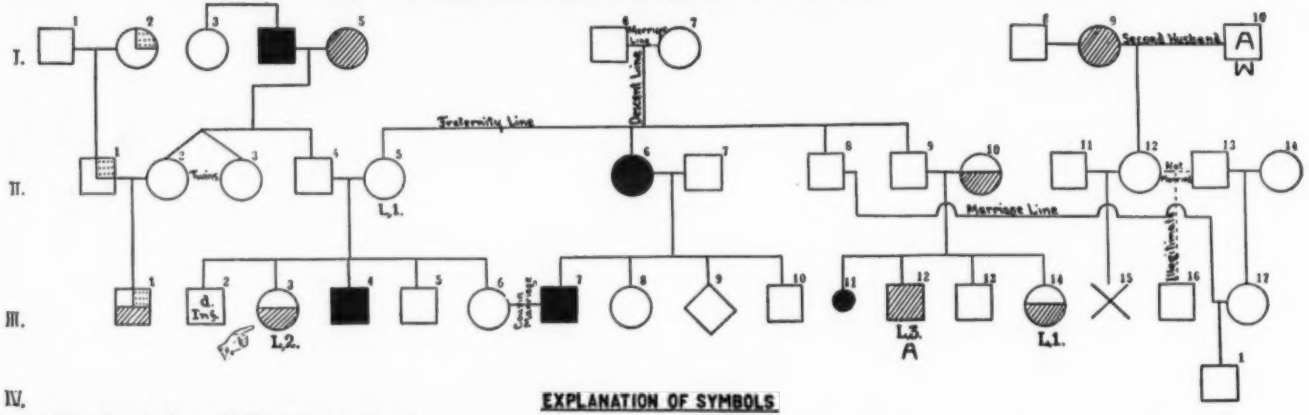
DRESEL, K. *Virchow's Arch. f. path. Anat. u. Phys.* 224:256-303. 1917.

SIEMENS, H. W., and E. KOHN. *Zeitschr. f. indukt. Abstam. u. Vererbungsl.* 38:1-61. 1925.

Literature Cited

1. BAUR, E. *Ber. Deutsch. Bot. Gesell.* 25: 442-454. 1907.
2. CORRENS, C. *Ber. Deutsch. Bot. Gesell.* 20:159. 1902.
3. CUÉNOT, L. *Arch. de Zool. exp. gén.* 3: 123-132. 1905.
4. IBSEN, H. L., and E. STEIGLER. *Am. Nat.* 51:740-752. 1917.
5. KIRKHAM, W. B. *Anat. Rec.* 11:480-481. 1917.
6. QUACKENBUSH, L. S. *Science, N. S.* 32: 183. 1910.
7. SCHÄPER, W. *Zeitschr. f. Züchtung. B.* 35:1-88. 1936.
8. STOCKARD, C. R. *Am. Jour. Anat.* 59:1-53. 1936.

SAMPLE PEDIGREE CHART SHOWING THE MANNER OF CONSTRUCTION, AND THE USE OF STANDARD AND SPECIAL SYMBOLS.



EXPLANATION OF SYMBOLS

(a). Standard for all Pedigree Charts:

□=Male; ○=Female; ◇=Sex unknown; ●=Still-birth or Miscarriage; X=Children — number and sex unknown; ○○=Twins; d. Inf.=Died in Infancy; ☞ Points to the Propositus or central figure in the pedigree.

□—○=Parents.

□○□○○=Children.

Roman figures to the left indicate generations; Arabic figures locate individuals, (thus III. 7 is the young man in the third generation who married his cousin).

The following letters, placed in or around the individual's pedigree symbol, are standard for certain traits: A, alcoholic; B, blind; D, deaf; E, epileptic, F, feebleminded; I, insane, M, migraineous; N, normal in reference to traits under consideration; Ne, neurotic; P, paralytic; Sx, sexually immoral; S, syphilitic; T, tuberculous; W, wanderer.

(b). Especially devised or selected for this particular pedigree-chart:

■ ● = Successful leaders in politics. ◱ ◷ = Extra thumb on right hand. L.1 = Highly successful author. L.3. = Little or no ability in literary efforts. ▨ ◍ = Superior in vocal music. ▨ ◍ = Medium attainment in vocal music.

To fit the particular family and traits (whether physical, mental or temperamental; good or bad) under consideration, invent special symbols, or select special letters (in addition to those standardized under (a) above) to be placed within or near the particular individual's pedigree symbol, to indicate particular traits and their degree of development.

Prepared by the International Commission of Eugenics. See *Journal of Heredity* for August 1926. Additional copies may be obtained from the AMERICAN GENETIC ASSOCIATION.

Material for Demonstrating Salivary Gland Chromosomes

Interrelated demonstration material—microscopic slides, chromosome maps, lantern slides and literature—make giant chromosomes available for classroom use.

MICROSCOPIC SLIDES OF SALIVARY GLAND CHROMOSOMES

Slide of Normal Salivary Chromosomes of *D. melanogaster*, each	$2.25
Three Slides	5.00
Slide with drawing identifying all chromosomes in two figures (Female)	4.00*
Slide showing Y-chromosome (Male)	4.00
Slide showing synapsis of normal and inverted X-chromosome (loop)	4.00*
Slide showing figure of an autosomal inversion	4.00*
Slide showing synapsis of translocated and normal chromosomes	4.00*
Slide showing a small deficiency (deletion)	4.00*
Salivary chromosomes of *D. virilis*	2.25
Three Slides	5.00
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